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Coatesville's Dam Assured

IN the face of opposition which was commented on editorially in the Engineering Record of Aug. 28, page 247, the State Water Supply Commission of Pennsylvania has refused to rescind its permit for the construction of the water supply dam at Coatesville. It would have been a severe blow to the engineering profession if the State authorities had allowed themselves to be stampeded by the cry that dams in general constitute menaces which, in Coatesville's case, would eventually result in a repetition of the loss of life and damage to property during the Erie flood. Coatesville needs a new water supply system, and the attempt to block the Rock Run plans, if successful, would probably have resulted in more deaths from typhoid than from the actual breaking of any structure across the creek.

Bonds for Road Oiling

THE principle that bonds should not be issued for longer terms than the life of the improvement has become generally accepted. It would seem, however, that as soon as a group of men is assembled as a Legislature, the supposed knowledge of the individual is often not reflected in his legislative acts, if he may be judged by the statutes so copiously and freely piled upon the public. Without insinuating that the Illinois Legislature surpasses other States in its output of silly and useless statutory writings, one amendment to the road laws of Illinois recently enacted makes such a capital illustration that it should serve as a horrible example. Who, if asked for how long a term bonds should be issued for oiling earth roads, would even suppose a bond issue would be thought of in such a connection? Yet the last Illinois Legislature amends the road laws permitting townships to issue 15-yr. bonds for "hard roads" by including within the scope of improvements that may be constructed "earth roads to be oil treated!" Whether any township will issue bonds for such a purpose is exceedingly doubtful. But this is not the point; the fact remains that the road laws of Illinois, as now written, do permit townships to vote 15-yr. bonds for an improvement that may last not longer than six months.

Why Not the Contractor?

A DISCUSSION arose as to joint leakage and methods of testing water mains at the convention of the New England Waterworks Association held in New York City, Sept. 7 to 9. Engineers expressed their opinions and told of their experiences, and waterworks superintendents contributed their part. But one voice that could have added much valuable information was missing. The contractor was not heard from. In that particular discussion he could probably have spoken with as much authority as any other class present. To the engineer and waterworks superintendent the test is but a small part of a large work, and, if his department is a large one, he is acquainted with the action of the individual joint mainly through the reports of his subordinates. To the contractor the test is the most important part of the work and the individual joint is a matter of grave anxiety and deep interest. A leak to him means added expense, great or little depending upon conditions, but never so small as to be neglected. The primary object of the waterworks associations and similar bodies is to spread knowledge and hasten progress by an exchange of the results of studies, opinions and experiences. The contractor would have been especially welcome because no one appreciates the value of his knowledge more than does the man who has had charge of the works he has constructed.

As the Coast Does It

ELABORATE and cordial entertainment has always been a characteristic of the annual meeting of the American Society of Civil Engineers, but it may well be questioned whether the social annals of the society show anything to equal the delightful surroundings and the completeness of the session at San Francisco last week. The actual happenings are recorded in the news section of this issue. That account, by itself, would do a gross injustice to the San Francisco association of the society, for it tells nothing of the long and hard labor necessary to carry through the Del Monte excursion successfully. San Francisco is favored, of course, by having the California scenery at hand, but it took courage to convey the visitors a distance of 125 mi., providing conveyance by special trains and automobiles and arranging for out-of-door luncheons on a marvelous beach and in the heart of a giant forest. The setting was ready, it is true, but hearts less cordial would never have used the setting. One feature will serve to show how thorough were the preparations for the excursion. One of the trips took the party by automobile from Santa Cruz, 66 mi. across the Santa Cruz Range and through the giant redwood forest to San José. Previously a member of the San Francisco association had motored over the route and taken speedometer distances to points of interest. These points were then described in geographical order in a guide book prepared for the occasion, and markers were placed at the roadside to correspond with the distance points in the guide book. Moreover, two maps of the region traversed were prepared, photos engraved and inserted in the book. Little more need be said than that the San Francisco association has made for itself a reputation of which it may well be proud.

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Engineering Economics

IT is notable that many of the papers presented at the International Engineering Congress this week treat their subjects from the viewpoint, not merely of technical detail, but of broad administrative policy. Briefly characterized, they might be said to emphasize the business side of engineering. This is true of the papers by Mr. Newell on irrigation, Mr. Stevens on railroads, and Mr. Lewis on city planning. Mr. Newell asks "Does irrigation pay?" and then proceeds to answer his question with statistics from reclamation projects in the United States and elsewhere. Some engineers might regard the question as one for the financier or economist and not for the designer and builder of works; but a broad conception of the duties of the engineer inevitably leads to the conclusion that it is part of his business to be sure of his foundations in this regard. Mr. Newell sums the matter up well when he says that if these works as planned and completed by the engineer are then found to be not financially successful, or not economically sound, he necessarily loses in the opinion of his fellow men. The business of the engineer is popularly supposed to be that of creating by the use of a dollar those results upon which the less able man would spend two dollars or more. If, however, the result of the dollar's expenditure is not capable of returning a fair interest and profit, then the engineer's reputation must suffer with that of others concerned. Obviously, therefore, he should devote thought to the economic as well as to the technical features of the works he plans.

Present-Day Railroad Building

RAILROAD building, the subject of John F. Stevens' paper at the International Engineering Congress in San Francisco this week, is a somewhat hackneyed topic, and the casual reader, looking over the abstract of this paper on page 381 and seeing subheads pertaining to "reconnaissance" and "pusher grades," may conclude at once that Mr. Stevens has said nothing new. And, in fact, he has not presented anything startling in its newness. Certain truths, however, and the adaptation of them to twentieth-century conditions, are so vital to successful railroad building, and are so often overlooked by promoters and locating engineers alike, that they are well worth reiterating. This Mr. Stevens has done in a clear and logical manner, leaving to others the details and dealing with only the broad business principles—the balancing of safe probable income against probable outgo, the determination of whether the line should be built at all, and, if so, where, of what character and at what cost. The engineer, in his zeal for balancing cut and fill precisely, for holding to certain maximum grades and curvature, and for keeping the cost of land to a minimum, must never lose sight of the larger questions of whether the road, as he locates it, will pay, and whether it will pay as well as some other location and will permit adequate expansion to meet future needs.

Economy with Cantilever Beams

THE possibilities of large saving in weight of steel-frame buildings, which can be effected by the use of cantilever beam construction, are shown by an actual example in the article on the Mannheimer Building in St. Paul, on page 392 of this issue. In spite of the fact that it contains an uneconomical truss of 119-ft. span, on which comment was made in the issue of Aug. 7, the steel for this building is designed with unusual economy. This journal wishes to correct any false impression which it may have created regarding this design. Special architectural requirements for the spacing of window openings enforced the use of the steep diagonals and short panels which caused the loss of economy mentioned in the case of the 119-ft. truss. Although comparisons based upon cubical contents are not conclusive, the striking values given in the article, showing a saving of over 35 per cent for this building, compared with the averages for similar buildings, seem convincing, especially when it is noted that the columns are designed to carry a future additional story.

The special design of cantilever girder-beams supporting intermediate suspended beams between columns has resulted in marked saving over the usual construction. As stated in the article, the length of the suspended beams was fixed with the idea of producing equal positive and negative bending moments in the cantilever girder-beams. Calling x the variable length of the suspended span, a formula for this variable can easily be developed. It will be found that the positive bending moment at the center of the cantilever beam and at the center of the suspended beam, for assumed full uniform loading of w lb. per linear foot, is $wx^2/8$ in each case, assuming no restraint at columns or at the end connections of the beams. By equating this value to the negative bending moment at the column, $w(l^2 - x^2)/8$, (if l equals the panel length, assumed constant throughout) and solving for the value of x, the length of the suspended span is found to be $0.708\ l$. For a panel length of 27 ft. 3 in., x is 19.3 ft., which checks closely with the value of 19 ft. 5 in. used by the designer in this building.

The foregoing analysis is based upon the assumption of full uniform load on all panels. If the live load w_l per linear foot be applied only on the cantilever beam panel, the positive bending moment at the center is of course increased. By equating its total value, $w_d x^2/8 + w_l l^2/8$, to the negative bending moment, $(w_d + w_l)(l^2 - x^2)/8$, the value of x will be found to be $l/\sqrt{2+r}$ if r is the ratio w_l/w_d. If the live load is equal to the dead load, for example, the value of x becomes $0.577l$. The positive bending moment, $wx^2/8$ for the suspended beam is of course decreased for this case, and these beams can be made lighter.

The principle applied by Mr. Payzant in the design of the beams in this building is certainly sound and undoubtedly results in economy, particularly for long panels. Although the theoretical formulas just given are suggestive, it should be noted that continuity of action, although certainly present both at the columns and at the end connections, is not allowed for in the analysis. The principle advantages of the design, in addition to its economy, are clear spaces for pipes to run down beside the webs of the columns and the ease in erection of the girder-beams outside of the columns. By the use of the diaphragms between the pairs of beams any eccentric stress on the columns, due to single panel loading, is greatly reduced, if not practically eliminated.

Sewage Effluents on Watersheds

ONCE again the question of the possible pollution of New York's water supply by the discharge of sewage from a State hospital on the Croton watershed presents itself for solution. Commissioner Biggs of the State Health Department has approved plans whereby the sterilized effluent from a sewage treatment plant, comprising Imhoff tanks and sprinkling filters, will be allowed "temporarily" to enter Mohansic Lake, which is tributary to Croton Lake and distant therefrom about 6 mi. This permit has raised such a storm of protest from New York City's representatives that it seems probable that the plans will be revised so that the effluent will be diverted from the Croton watershed and carried through a long sewer into the Hudson River.

In its general features the case is precisely similar to the one presented three years ago when the location of a tuberculosis hospital in Westchester County was under discussion. The Engineering Record sees no reason for changing the opinions expressed on this subject in its editorial columns Nov. 30, 1912, page 595. While the danger of contaminating Croton water with the treated sewage is, admittedly, remote it is best to follow a very conservative policy in matters affecting the health of several million people. The trouble is that skilled operation of sanitary works is not generally insisted upon in this country. If the day arrives when every sewage treatment plant is placed under the constant supervision of a sanitary engineer or a chemist it will be possible to place more dependence upon the effluent. That time has not yet arrived, and where a municipal water supply is not filtered, as is the case with Croton water, a sewage effluent which is allowed to reach a reservoir is a constant menace to public health.

Conservancy Legislation

AFTER being bitterly fought through all the courts of the State, the Ohio Conservancy Law is at last firmly established; and the Indiana Legislature, at its last session, passed a group of bills permitting the organization of various kinds of districts for conservancy and flood prevention work. The Engineering Record has already commented upon the organization, under the Ohio law, of the important districts under the lead of the cities of Dayton and Columbus. Recently the Upper Scioto Drainage and Conservancy District has been organized in Hardin County, Ohio, and petitions have been filed for the formation of a district in the basin of the Ottawa River. Campaigns are well under way for the carrying out of flood-prevention work under the new Indiana law at Fort Wayne and Kokomo, and steps are under consideration at other points.

Credit is due to the Buckeye State for having evolved out of the disasters of the spring of 1913 so effective a method of expressing its enterprise; and Indiana places itself well in the van of the States by following so closely the example of Ohio. But all of these projects are most significant as straws which show the way the wind is blowing. These activities are but typical of the growing interest in flood prevention throughout the country. There is little doubt that more and more legislation of this character will be passed during the next few years.

Such legislation, if successful, must take advantage of the experience under these pioneer laws and must be based upon a knowledge of their weaknesses as well as their strong points. It is interesting to note, therefore, that the defects in the Ohio law are already beginning to be apparent. The Upper Scioto district, with headquarters at Kenton, is located in the same basin as the district which centers in the city of Columbus. The upper district is flat and includes within its limits a great onion marsh which is perhaps the most important economic feature of the district. Its great problem is a drainage problem—to get the water away from its fertile lands as promptly as possible. The lower district includes the capital of the State and one of its wealthiest communities. Its problem is to protect a great concentration of property value from the effect of floods, and the project which is being developed as most effective and economical involves the storing of flood waters in the upper reaches. It is already apparent that conflict of plans is probable. For such cases the Ohio Conservancy Law provides only a contest before the courts by the proponents of the conflicting plans. The result is more apt to be a compromise, less well adapted to the needs of either district, rather than a comprehensive correlation of plans so as to secure the most economical result and the greatest possible benefit for the entire basin.

It is important that future legislation of this character shall not ignore the fact that a stream is a unit from its source to its mouth; that States, counties and other political sub-divisions are artificial rather than natural units; and that the problem of flood control, broad as it is, is but one phase of the still larger and more important problem of water conservation and stream regulation. The prevention of such conflicts as appear likely to result from conditions in Ohio, as well as efficiency, economy and the greatest good of all the people, should require that plans for conservancy projects should be subject to the review of State and National conservancy commissions, endowed with ample resources and authority, and charged with the harmonizing of local interests and the co-ordination of the needs of water supply, water power, flood control, navigation, drainage and irrigation.

What the Pan-American Road Congress Accomplished

A JOINT convention of the two National highway organizations has so long been urged and its benefits so often explained that any such combined meeting would be predestined to success if for no other reason than by sheer force of the moral support that would be unconsciously extended by all. A joint convention was the only logical outcome, since both associations desired to meet on the Pacific Coast, and the total number of delegates from both organizations who could be expected to travel so far from the eastern centers of road-building activity was needed to constitute a representative gathering.

The first question as to what the Pan-American Road Congress accomplished is naturally in regard to any permanent plan for joint annual sessions. While no definite action on this subject was taken it may be assumed that the committee appointed to "consult with similar committees of other organizations called for the purpose of bringing into closer relations the efforts for road improvement in the eastern and western portions of the United States, and to consider suitable recommendations for such changes in the constitution and by-laws of the association as will best secure these desired resolutions" will consider the question of a joint session next year. If a permanent arrangement for a joint annual meeting results, this alone will have made the journey to the Coast worth while.

Although some excellent papers were presented, the sessions were not as well attended as would have been expected at a convention in the eastern or middle-western centers and, in fact, not a few of those who went to California primarily to attend the meetings were kept away from some of the sessions by other attractions found in the Exposition City. This neglect, however, cannot be charged entirely to the delegates, for several features of the convention plan militated against maximum attendance.

The fact that Oakland, where the meeting was held, is the terminus of the Lincoln Highway was not a sufficient reason for holding the sessions in that city at a point more than an hour's travel from the Exposition grounds in San Francisco. A meeting hall within a 20-min. ride of the Exposition would have made it possible to open sessions more nearly on time and would undoubtedly have increased attendance and greatly lessened the inconvenience and formality of conducting proceedings from a stage. The bad acoustics in a hall with 1200 empty seats was also in sharp contrast to the comfortable rooms seating 200 or 300 that were used in San Francisco by other conventions.

One point in the discussion that aroused interest far more intense than any other was a phase of "preparedness" entirely within the field of the road builder. On this score officials responsible for the Congress are to be heartily congratulated on the stand taken and the spirit shown in the debate that continued 2 hr. beyond closing time to get at the bottom of the question. The opposition cry of the pacificists was heard when the word military was introduced in the resolution (given in full elsewhere), and under the claim for a right to equal distribution of Federal attention to all parts of the country, eloquent argument against the resolution was offered. Fortunately the desire for peace and safety and the real facts of the case were deeply impressed on the minds of those who fathered the resolution and the opposition only brought out the significance of underlying principles in a way that startled the convention and won almost unanimous support for the measure. Broad-minded men having National interests at heart, big men who are above the suspicion of scheming for petty private interests, are sorely needed in such crises.

Smoke Prevention Difficulties

SMOKE in Chicago is gradually becoming less of a nuisance as more and more of the older plants go out of commission and the owners and officials come to a better understanding in the enforcement of the smoke ordinance. Following the adoption of the "thirty-day rule" in January, 1914, the number of violations reported per hour of watching per observer immediately dropped off more than one-half. Under this rule two violations observed upon a stationary plant or marine craft during thirty consecutive days constitute sufficient cause for suit. When a violation is observed a letter of warning is sent the owner. This stringent policy was adopted after the Smoke Department had labored incessantly for several years with plant owners in an effort to clean up their stacks. It was found that the "constant smokers" remaining needed to be controlled with a stronger hand. That the policy is sound is indicated by a chart shown at the recent convention of the International Association for the Prevention of Smoke at Cincinnati by S. H. Viall. In 1910 the average smoke density of stationary plants was 6.5 per cent. In the next four years it dropped by the following steps, 4.7, 4.6, 3.8 and to 3.4 per cent for 1914.

Locomotives showed a much greater fluctuation. In 1910 the smoke they emitted had a density of 22.3 per cent; in the next four years, 7.4, 10.7, 6.1 and 7.4 per cent respectively. The suit policy against railroads is similar to that applied to stationary plants, and has been developed from data compiled from a number of years' experience which indicate the relative opportunity the Smoke Department has of seeing locomotive stacks, due to the number of engines operated in the city by the railroad, to the location of the railroads, and to the opportunity of observing locomotive stacks as compared with the opportunity of observing the average stationary stack. Taking these factors into consideration a schedule was worked out which allows the different railroads a varying number of violations per month. If a railroad is observed violating in excess of the number allotted to that road, suit is started upon the evidence of all violations reported for that month.

That this record is not accomplished without great effort, patience and a certain amount of co-operation on the part of the public was brought out very distinctly by Mr. Viall. One of the difficulties of the smoke inspector's position—and of any other inspection service requiring a duplication of the same effort—is the danger of getting into a routine rut. Firemen will quickly learn if they are caught violating only during certain hours. Speaking of the rut of routine, Mr. Viall believes that the smoke inspector is to be pardoned when he feels that all parties offering excuses or reasons for violations of the smoke ordinance are traveling in the same rut. There is but little variety in the explanations received. At times the inspector is tempted to get out a set of printed forms so as to save his friends the trouble of dictating and himself of reading the same stories over and over again.

As to the co-operation on the part of the public many citizens think all that is necessary is to make a complaint to the smoke inspector's office. This helps to a certain extent, but not as much as if the citizen also complains directly to the owner. Many plant owners tell the smoke inspector that no one in the neighborhood is complaining, that the smoke inspector himself is the only one who is finding fault, and that he, the smoke inspector, is doing so merely to be officious and make trouble.

It requires effort on the part of the public, as well as patience of the officials, to follow matters through the courts and for that reason any other amicable method seems in the end to be extremely desirable. One of these tried in Chicago with success is to promote a rivalry between owners and their employees so that each will try to have a better average smoke density record than his neighbor. The department notifies the owners from time to time of their position in the honor list.

New Plant Marks Further Step in Development of Deerfield River, Massachusetts

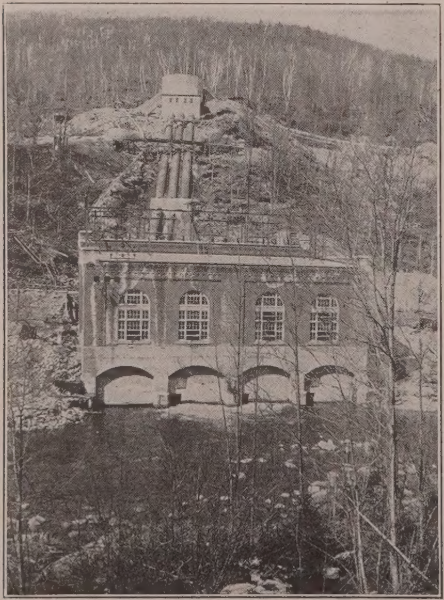
Construction Costing Nearly $1,500,000 Completes Another Link in the Development of This River—Part I, Design

THERE APPEARED in this journal Feb. 1, 1913, page 116, Feb. 8, 1913, page 153, and Feb. 15, 1913, page 181, a series of articles on the general scheme for the complete development of the Deerfield River in Massachusetts and a description of the first steps toward carrying out that scheme. At that time there were under construction the three hydroelectric stations near Shelburne Falls, the Somerset storage reservoir, and the power house only of the Hoosac Tunnel, or No. 5, station. Up to January, 1915, the last-named station had been used as a frequency-changer station. The present article deals with the design and construction of the structures necessary for converting this electrical substation into a hydroelectric plant utilizing a head of 240 ft. The work deserves special attention because of the remarkably short period of time in which it was completed. It was started the last of April, 1914, and on Jan. 20, 1915, power was delivered to the line. The cost was nearly $1,500,000.

General Features

The completed plant conforms to the original general scheme, but differs in detail to the extent that instead of a new dam being erected about three-quarters of a mile below Monroe Bridge, as at one time contemplated, rights were acquired to take water from the Monroe Bridge dam. While this arrangement added about 33 ft. to the normal operating head and did away with the construction of a new dam, it did not simplify the construction, as it added a complicated intake structure, an 1100-ft. tunnel, 2200 ft. of 12-ft. reinforced-concrete conduit and about 600 ft. of canal.

The work involved in completing the hydraulic part of the plant consisted of an intake at the dam, three sections of 12-ft. reinforced-concrete conduit with a total length of 5000 ft., three sections of open canal with a total length of 9800 ft., four concrete transition structures, one special spillway and brook-intake structure, a concrete surge tank, three 7-ft. steel penstocks with a total of 1600 ft. and three 7500-hp. turbines.



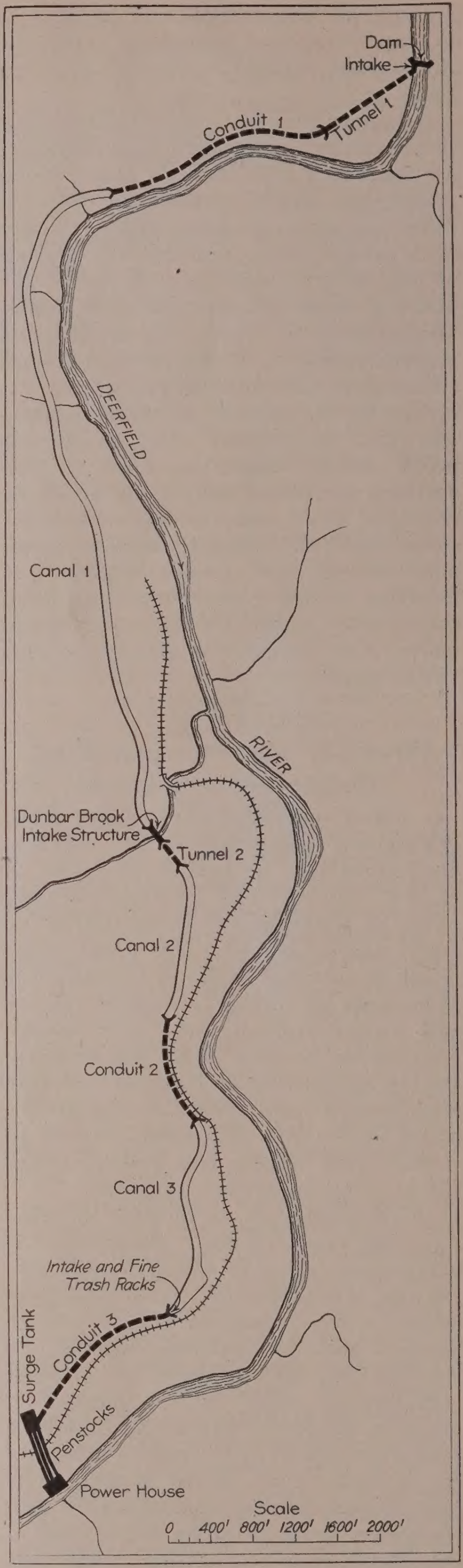
SURGE TANK AND POWER HOUSE

General studies only had been made of the design previous to the beginning of the work, so that the designing and detailing was done just ahead of the construction. In the work of designing, simplicity for the sake of ease in construction, consistent with maximum operating efficiency of the completed plant, was constantly kept in mind. The question of pondage was of much importance for the operation of the plant, and a general rule followed in determining between conduit and canal for any given location was to build canal if practicable, even to the point where it might cost considerably more than conduit.

Intake and Conduits

The intake is a concrete structure, entirely on ledge, at the west end of the old dam at Monroe Bridge and occupies the site of a former pulp mill building, which had to be demolished to make way for it. By careful study the structure was designed to increase the spillway length of the dam proper from 111 to 141 ft., by passing the water to the intake through a double rectangular passage underneath the concrete spillway. The water from the spillway passes over the roof of the intake entrance and thence off the side of the structure to the channel below. The intake water passes through the double passageway to an open well about 50 ft. downstream from the crest of the dam. On the river side of this well are two submerged sluice-gates 7 ft. 9 in. x 8 ft. and over these gates a spillway at an elevation 3 ft. above the elevation of the dam crest. On the downstream side of the well, and at right angles to the submerged sluice-gates, is located the main intake, with an opening of 12 ft. 6 in. x 13 ft., controlled by a gate made up of a structural-steel frame filled with concrete. Downstream from this main gate is located a Stickney siphon spillway with a throat of 20 sq. ft. The three gates in this structure are operated by a motor located in a gatehouse over a part of the structure.

From the intake structure the water enters a tunnel 1100 ft. long, about 400 ft. of which is through rock and 700 ft. through earth. The tunnel through rock, equivalent to a 16-ft. circular section, is unlined except for the seals near the ends of the rock section. The section through the earth is horseshoe shape and equivalent in area to a 12-ft. 2-in. circular section. At the lower portal the tunnel is made continuous with the first of the three 12-ft. circular reinforced-concrete conduits. All three sections of these conduits are placed on a bench cut in the sidehill. Conduit 1 is 2200 ft. long. At its outlet to canal 1 there is a transition section, in the design of which an attempt was made to conserve the velocity head of the water flowing in the conduit by means of such a structure as would give a well proportioned velocity-distance curve. This same type of structure was also used at two other points.

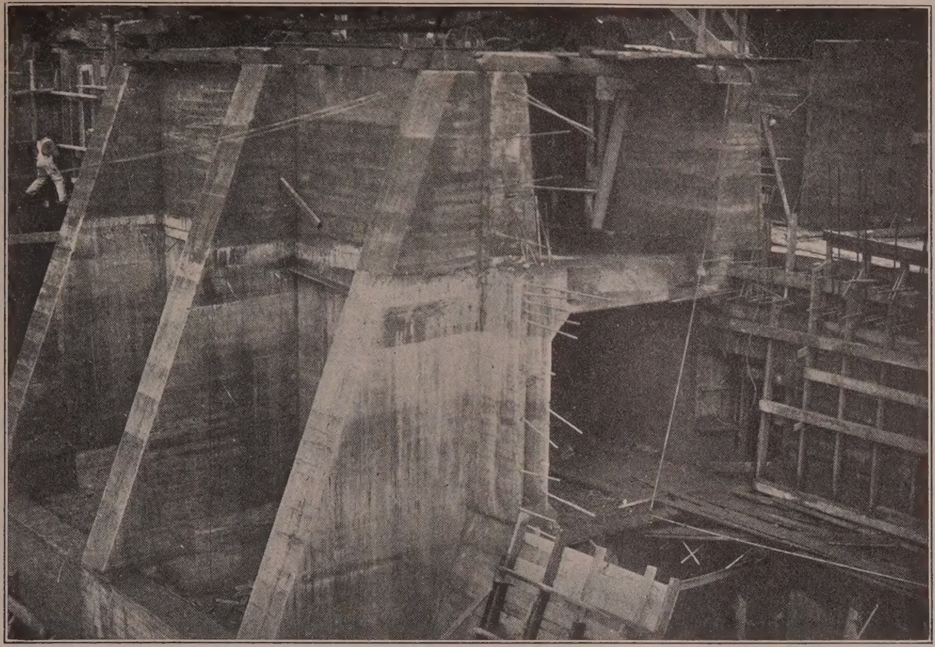


GENERAL LAYOUT OF WORK

Canal 1 extends 6600 ft. and, in general, follows the contour of the sidehill, the material being removed from the canal prism and placed in an embankment forming the lower side of the canal.

Dunbar Brook Structure

At the lower end of canal 1 a brook with 12 sq. mi. drainage area intersects the line of canal. This brook with its steep descent has the reputation of being a torrent at times. Briefly the problem here was to deal with the brook in a manner to allow the utilizing of the water from it under all ordinary conditions and still furnish means



CANAL FLOWS INTO LOWER PASSAGES OF DUNBAR BROOK STRUCTURE

of passing the floods without endangering the safety of the canal. At the same time it was considered a desirable place to locate a canal spillway. The valley bottom is of earth and boulders, with the exception of one side at the foot of a steep nose of ledge rock. The width of the valley is about 120 ft. at canal grade. To have placed a straight spillway across the brook, forming the lower side of the canal would not answer, first, because sufficient length could not be obtained at a reasonable cost, and, second, even if length were obtainable the brook always would have been a menace to the safety of the canal. The aim, therefore, was to separate the canal and brook, thus eliminating all danger to the canal from the brook, and still being able to utilize the flow from, and the pondage of the brook.

An attempt at a description of the structure is as follows: Approach the structure from canal 1 and bear in mind the right-hand side is the uphill side. First, consider the use of the structure to the canal. Water enters two rectangular passages which extend about two-thirds of the way across and then are combined into a single passage. These two passages are inter-connected horizontally. The left hand side of the structure is carried to the desired spillway elevation. The wall between the two passages is also carried solid above the roof to the spillway elevation. The roof of the left-hand passage has openings which allow water to pass to or from the upper trough in addition to the free access from the canal end. When water becomes high it can spill to the left into the old brook bed or to the right onto the top of the roof of the right-hand passage and from here flow forward out over the roof of the structure to the brook below, and also by two culverts, which lead from the roof of the right-hand passage down and under the structure to the rock below. This part of the structure furnishes the desired canal spillway.

RELATION OF STRUCTURE TO BROOK

Now, consider the relation of the structure to the brook. The right-hand side of the structure is carried to the desired spillway elevation for the brook. This wall extends along the upper side of the structure to a point about 30 ft. beyond the end of the canal spillway described above. It then crosses the roof of the main waterway to the lower side and extends along the lower side to the portal of a tunnel under the ledge nose. This wall furnishes the desired spillway for the brook, and water spilling from the brook passes along the roof of the right hand main waterway passage, through the two culverts underneath the passages, directly over the roof of the one main passage and also, at the forward part of the structure, directly into the old brook bed.

A 4 x 5-ft. double-pressure wooden gate in the right-hand side of the main waterway controls the flow of the water to or from the brook. A 5 x 5-ft. cast-iron gate in the right-hand side of the structure, with a culvert underneath the main waterway, can be used to drain the upper side of the structure and handle the flow of the brook at ordinary stages without interfering with the passage of water to the plant. A 4 x 4-ft. cast-iron gate is located on the downstream side of the main waterway near the tunnel end, and may be used to drain canal 1, the structure, and tunnel 2. One surface sluice-gate, 10 ft. wide, is located at the forward end of the canal spillway and controls the water in the left-hand trough over the main waterway. A duplicate gate is located in the brook spillway crest 25 ft. toward the tunnel from the canal spillways. These two surface sluices may be used for disposing of floating débris.

A concrete platform supports the five gate hoists, and a wooden platform supported by concrete piers extends to either end from this.

The over-all length of the structure, including the canal embankment wing walls, is 225 ft. Yet there is about 150 ft. of brook spillway length and about 200 ft. of canal spillway length, or a total of 350 ft. of spillway length in the structure. It is believed that with water standing at the maximum desirable elevation in the canal it would be impossible to get a rise exceeding 1 ft. under the most severe conditions.

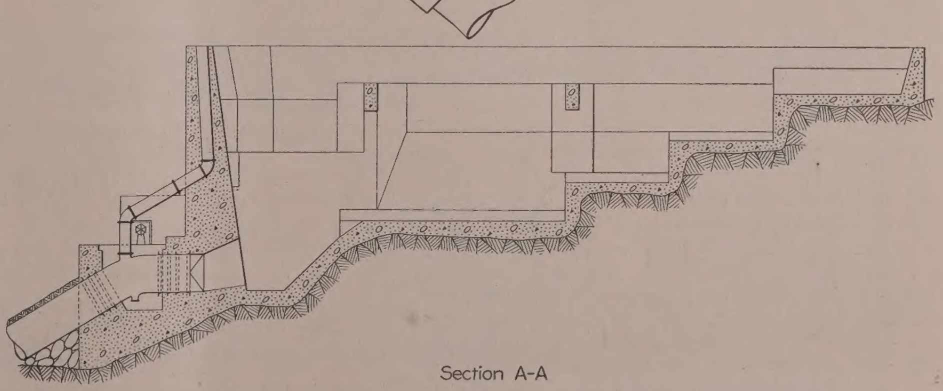
DUNBAR BROOK TO SURGE TANK

Water passes directly into tunnel 2 from the Dunbar Brook structure. This tunnel is 320 ft. long through the ledge nose. It has a nominal diameter of 16 ft. and is unlined. Then comes canal 2, which is 1500 ft. in length. One thousand feet of conduit follows canal 2 and then canal 3, which is 2000 ft. long.

At the lower end of canal 3 the intake is provided with fine trash racks. These are the only racks the water passes through. From this intake the water flows through 1800 ft. of conduit to the surge tank.

SURGE TANK

The surge tank is a heavily reinforced-concrete structure with side walls backfilled, rectangular in plan, about 44 ft. x 160 ft. in outside dimensions, and extends from elevation 870, on the front or down-



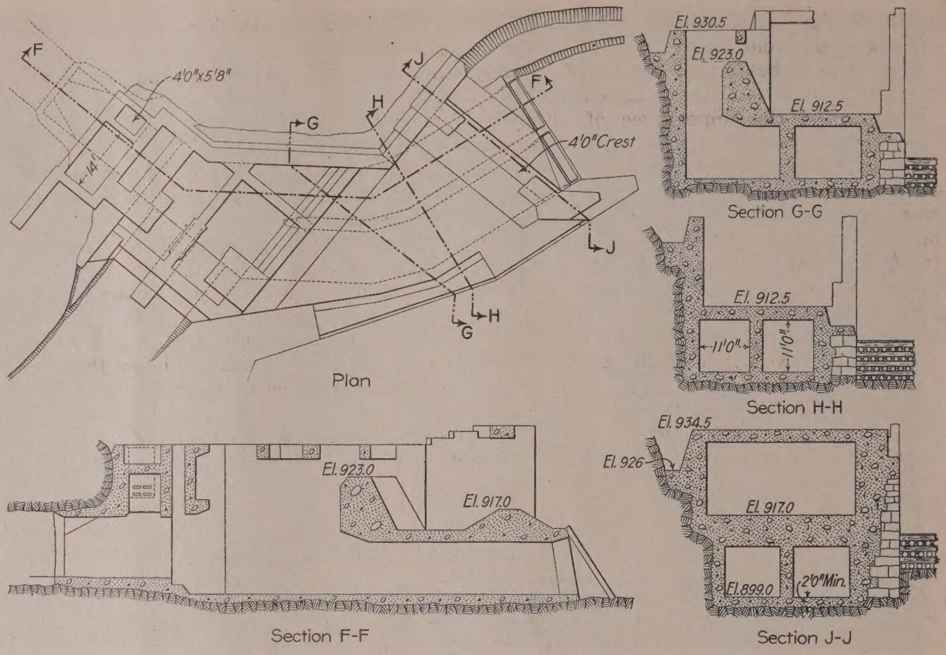
SURGE TANK STEPS WERE FITTED TO THE NATURAL RISE OF THE SLOPE hill end, to elevation 930. The conduit enters it at an angle, well to the front, with invert elevation of 894. In section, looking at it from the side, its floor rises in steps. These steps fitted approximately the natural rise of the original slope. In front of the front wall of the tank proper is a gatehouse which shelters the motors and other operating mechanism of three 7-ft. butterfly valves. The valves are located in a recess in the substructure of the forward part of the tank and control the three 7-ft. penstocks. In the same recess are located three cast-iron elbows joined to the valves, which make the turn from the horizontally placed valves to the sloping steel penstocks. From the top of these elbows 24-in. steel air-vent pipes extend up through the gatehouse to the front wall of the tank proper, then, embedded in the center of the wall, they extend to the top of the tank.

Penstocks and Wheels

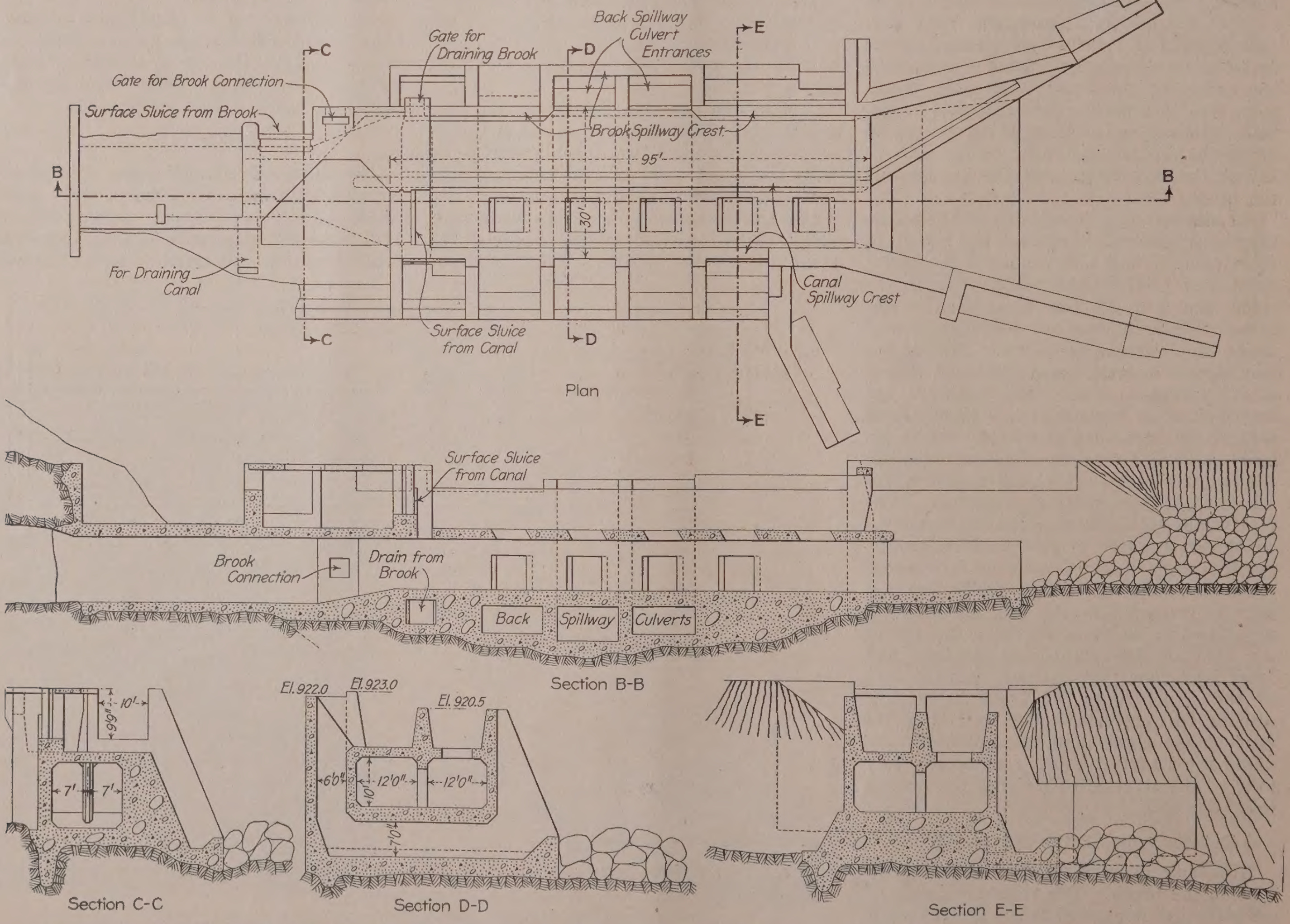
The penstocks were designed to take the excess pressures due to probable load fluctuations, without the aid of relief valves. However, as it was impossible to predict how severe the future load conditions of the plant might be, provision was made whereby relief valves might easily be installed in the future if found necessary.

The penstocks, heavily anchored at the ends, are laid in earth trenches, and with the exception of one concrete anchorage half way down the hill they are held in place simply by well placed backfill. The pipes are 7 ft. in diameter and about 550 ft. long each. At the power house they pass from the rear of the station by means of bays, provided in the substructure, to the side toward the river where the turbines are located. They were furnished and erected by the William B. Pollock Company, of Youngstown, Ohio. A second set of butterfly valves, hydraulically operated, is located in the basement of the station, about 36 ft. back from the center line of turbines.

The waterwheel equipment, including the butterfly valves, was furnished and erected by the Allis-Chalmers Manufacturing Company. The wheels are of the horizontal, single-runner Francis type, with spiral casings and have a capacity of 7500 hp. each. Each unit drives a double generator, operating at 300 r.p.m. and composed of a 60-cycle and a 25-cycle machine. These double generators have been operated for the previous two years as fre-



INTAKE DESIGNED TO INCREASE SPILLWAY LENGTH OF DAM THIRTY FEET



DUNBAR BROOK STRUCTURE ALLOWS UTILIZATION OF WATER OF OCCASIONALLY TURBULENT STREAM WITHOUT ENDANGERING CANAL quency changers between the company's 25-cycle and 60-cycle lines.

The draft tubes are of steel and are incased in concrete below the basement floor.

Because of the importance of allowing new embankments to become settled and because of the very severe winter conditions under which the last part of the work was completed the plant has thus far been operated without flashboards, at levels 5 to 10 ft. below the maximum contemplated.

George W. Bunnell, president of the Power Construction Company, was the active administrative head, and personally directed the execution of the construction work, with F. W. Barnes as principal assistant. A. A. Conger, hydraulic engineer, was responsible for the design and proper execution of the work. C. F. Cook was resident engineer in charge of field engineering, and A. C. Eaton, assistant hydraulic engineer.

The plant was built as an addition to the New England Power Company's system of plants, operated by the Connecticut River Transmission Company, the managing and financial representatives being Chace & Harriman, Inc., and Baker, Ayling & Company, of Boston.

Overhaul Bubbly Creek Filters After Seven Years

Sand Found Clean, Gravel Dirty in Spots—Air Pipes Three-Quarters Full of Sand and Many Broken at Header Connections

AFTER seven years of service the filters at the Bubbly Creek plant of the Union Stock Yard & Transit Company, Chicago, were overhauled for the first time and the condition of the underdrains and sand was noted carefully by C. A. Jennings, superintendent. The eight filters have a combined filtering area of 2507 sq. ft. Both air and water are used to wash the 2½ ft. of sand, which has an effective size of 0.40 mm. and a uniformity coefficient of 1.70. The sand rests on 9 in. of graded gravel ranging in size from ⅝ to ⅛ in.

UNDERDRAIN SYSTEM

The underdrain system was described in the Engineering Record of Dec. 12, 1908, page 661, as follows: "Off the main header thirty-two 2-in. galvanized iron laterals extend at right angles. These laterals are each 4 ft. 8 in. long and are tapped into the main header at intervals of 10 in., center to center, and at a point slightly above the center of this pipe, but precisely on the concrete floor of the filter in which the main header is embedded.

"At intervals of 6 in. brass tees are screwed into the top of these 2-in. laterals. The arms of these tees are 4 in. long and each arm contains eighteen slots about 1 in. in length and 1/64 in. in width. The total open area of these strainers in each filter is about 0.35 sq. ft.

"For agitating the sand layer during washing, compressed air is used. The air line enters each filter as a 4-in. cast-iron pipe branching at the entrance into two 3-in. lines of cast-iron pipe. These two lines extend along the long dimension of each filter tank about 4 ft. from the outside of the tank in each case. In both sides of these pipes ⅜-in. brass laterals are screwed horizontally. These laterals are set 4 in. apart, center to center, about 10 in. above the strainers, described in the last paragraph, and contain slots on both sides at intervals of 3¾ in. These slots are each about ½ in. long and 0.01 in. in width."

SAND IN THE AIR PIPES

All of the 3-in. header air pipes were found to contain sand, most of them being three-quarters full. As the outlet for the air from these pipes into the ⅜-in. laterals was at the bottom of the 3-in. pipes, little air could get out of the headers. Many ⅜-in. pipes were found broken away from the tees in the 3-in. pipes at the threads. Mr. Jennings is of the opinion that much of the sand found entrance at these points.

About 75 per cent of the air-pipe slots were stopped up completely with sand, which was removed by washing with water and a wire brush and by blowing out with compressed air under 30 lb. pressure.

No sand stuck in the strainer pipe slots and there was no sand inside these pipes. Some of them had a coating of slimy mud, which was removed by the same means used on the air pipes. Quite a few of the strainer pipes were found broken off from the tees at the threads, the weakest point in the thin brass tubing. These breaks permitted a larger volume of water to be applied to some parts of the bed, a condition resulting in poor washing.

SAND CLEAN

The sand was found to be fairly clean in spite of the condition of the air pipes. However, the overhauling was started as soon as the broken pipes were discovered. The gravel was found dirty in spots.

No cost data were kept after the work had progressed for two days, when the superintendent noted the "speed" that was not made. On the first filter it took five men 5½ days to take out the sand, air pipes and strainers, and then replace them. The same operation for the second and third filters required five days and for the five remaining filters, ten days.

Models, Properly Designed, Show Correctly Performance of Dams and Turbines

Theory Does Not Indicate That Full-Size Structures and Wheels Should Develop Markedly Higher Efficiencies than Small-Scale Replicas

By B. F. GROAT
Hydraulic Engineer, Pittsburgh

I HAVE always supposed that a pool at the foot of a dam was the most effective method of absorbing the kinetic energy due to the fall. If a jet of water be directed into a relatively large body of water the result must be the complete absorption of all the kinetic energy of the jet. This energy must appear in the form of heat and a rise in level of the pool unless the section of the pool is so much larger than that of the jet that any rise in level is impossible owing to the off-flow in all directions. That is, the entire kinetic energy is converted into heat except the very small residue necessary to conduct the water away. The very interesting question of design for a pool, or water cushion, will probably be best answered by tests upon actual dams and upon models. I have made some study of the theory of models with the conclusion that hydraulic models, if not too small to introduce relatively large effects due to viscosity, surface tension and molecular interactions between water and solids, must give very decisive results.

In particular if a study of the resistance of surfaces similar to those of the dam and model, including the channel below, be made and the surface of the model be so constructed that the skin frictions of the dam and model are proportional to the squares of the corresponding velocities over homologous surfaces, then the dam and model must perform almost exactly alike.

The reasons for these conclusions are more apparent after an examination of the theory of hydraulic models which I give as it appears to present itself to me, basing it upon the usual theory of models and propositions of similitude.

SIMILARITY OF HYDRAULIC MODELS

In designing an overfall dam it may be desirable to experiment with a model. The question then arises how far we may safely go in drawing conclusions as to the action of the water in the case of the real structure from experiments on the model.

It is a simple matter to make the model geometrically similar to the full-size structure. This must be done by making the linear dimensions of the model in a given ratio to their homologous dimensions in the full-size structure. Thus, if r be any given dimension of the structure and r_1 the homologous dimension of the model, $r = lr_1$, where l is a fixed ratio between all homologous linear dimensions, or $1/l$ is the scale of the model.

The question now arises what mechanical conditions must be imposed in order that the water flowing over the model may act in exactly the same way as it does over the real dam, but on the same reduced geometrical scale. In other words, two homologous particles will describe exactly similar curves, the scale of one being l times that of the other. When this condition is imposed it will be said that the real dam and its model are mechanically or dynamically, as well as geometrically, similar.

It is a well-known fact that if each of the forces of a system of forces acting upon a particle be increased in the same ratio and the mass of the particle be also increased in that ratio, the motion of the particle will be exactly the same as before, both as regards velocity and scale of motion; for example, two pendulums of exactly the same size and shape but of different materials when oscillated in vacuo over the same amplitude.

Two machines, therefore, made on the same geometrical scale but of different materials will be geometrically identical, but they will differ mechanically, since any two homologous forces in two similar systems of forces necessary to produce equal motions will not be equal, but will bear a constant ratio to each other. Thus the two mechanically similar systems of forces are so related that any force in one bears a given ratio to its homologue in the other system.

Corresponding, therefore, to the ratio of dimensions, if F and F_1 are respectively any force acting upon a particle of water in the case of the real dam and its homologue, in the case of the model, we have $F = fF_1$, where f is the constant ratio between homologous forces.

Gravity, however, imposes the limitation that forces acting upon homologous particles must be proportional to the masses of the particles, that is, to the cubes of linear dimensions where water is employed in the experiments on the model. In case some other liquid be employed in the experiments on the model, this ratio would be modified in the ratio of the densities of the two liquids.

Confining ourselves to the case of water as a liquid for the experiments, it must follow as a consequence of the limitation due to gravity that homologous accelerations in model and dam must be equal since, by reason of the limitation, homologous inertias are also in the ratio of the cubes of linear dimensions. Therefore, we have

$$V^2/r = V_1^2/r_1$$

or, velocities are proportional to the square roots of linear dimensions, since homologous accelerations are determined by forces which are proportional to the masses upon which they act.

Thus far nothing has been said about skin friction, viscosity, surface tension, adhesion and cohesion. Forces which result from these do not ordinarily follow the rule for forces resulting from gravity. An exception results, however, in the case of skin friction where the surface of the model can be made of such a character that the homologous skin frictions of the dam and model are proportional to the corresponding homologous areas and squares of velocity; that is, such that, for skin friction,

$$F/F_1 = (AV^2/A_1V_1^2)x$$

From the condition of equal accelerations imposed by gravity and from the ratio of scales of dam and model, we have

$$V^2/V_1^2 = r/r_1$$

and

$$A/A_1 = r^2/r_1^2$$

Therefore

$$F/F_1 = AV^2/A_1V_1^2 = r^3/r_1^3$$

or, homologous skin frictions are proportional to the cubes of linear dimensions, the same as gravitational forces, provided the surface of the model can be so constructed that skin friction relatively to homologous parts of dam and model is proportional to area and square of velocity.

In the case of ship models the skin friction and residuary resistance are usually treated separately, the residuary resistance being proportional to the cubes of linear dimensions. But if the surface of the model could be made smooth enough the total resistance should follow the law of proportionality to the cubes of linear dimensions. The reason why the law usually fails for the total resistance in ship models is that the coefficient of skin friction decreases with the length, so that to correct this it would be necessary to make the surfaces of the model smoother than the surfaces of the ship.

There is one difference between the action of a model dam and a model ship which should be noticed. In the case of the ship the relative velocity of the water along the ship begins at a maximum and decreases along the sides, while the reverse is true in the case of the dam. It is very likely, therefore, that a model dam can be more easily constructed in the sense of mechanical similarity of skin frictions than a model ship, for the difference in length of dam and model would have less effect than in the case of ship and model.

MODEL TURBINES

The foregoing theory applies directly to model turbines, and the tests on these, perhaps, afford the best proof of the correctness of the theory. Where there have been differences between the performance of turbines and their models there have also been material differences between the full-size turbine and its model, as regards the water passages, guide cases and draft tubes, if not in the runners themselves. In other words, the model, in such cases, was not a real small-scale replica.

The same rule as to skin friction applies to turbines and other hydraulic models as to model dams. The surfaces of the model should be so constructed that skin friction will be proportional to areas and squares of velocities. If this rule be adhered to models of turbines, and hydraulic models in general, should give very correct indications of the performance of the full-size machine.

The theory does not indicate that the efficiencies of large-size machines should be materially different from those of their models, unless the models are so small that viscosity, surface tension and other molecular actions come into undue prominence in the model.

The foregoing theory is applicable to hydraulic models of all descriptions, where gravity limits the ratio of forces to the ratio of cubes of linear dimensions.

The Engineer a Practical Idealist

Extracts from Presidential Address of Charles D. Marx Delivered at Forty-seventh Annual Convention of American Society of Civil Engineers in San Francisco Sept. 16

ANSWERING the charge that engineering and idealism are of necessity incompatible, Charles D. Marx, in his presidential address delivered before the forty-seventh annual convention of the American Society of Civil Engineers in San Francisco, Sept. 16, by citing such cases as those of the municipal and sanitary engineer who makes possible the physical development of cities, the bridge builder, the railroad pioneer, and the irrigation engineer, proved convincingly that the technical man is not only an idealist but a happy combination of the idealist and the utilitarian—in other words, a practical idealist, a man who first dreams and then makes his dreams come true. The aqueduct builder, for example, sees more than the number of lineal feet of conduit laid each day. His imagination looks forward to the prosperity in the city miles away which will follow the completion of a system for delivering an abundant water supply. Professor Marx said, in part:

Let us turn in detail to various branches of our profession, and see if the practice of them is likely to be destructive of idealism. The Mosaic code of laws shows that the health of the Jewish population was a matter of such supreme interest that special legislation on that subject seemed warranted. The Greeks, and particularly the Romans, recognized fully the moral value of personal cleanliness, but it has been left to our country to show clearly and on the basis of scientific study the interdependence between sanitation and disease, sewerage and crime. Munsterberg has said, "Hygiene can prevent more crime than any law." Speaking before the Massachusetts Conference of Health Officials, Dr. Charles W. Eliot, president emeritus of Harvard, addressed them, in part, as follows: "The progress of knowledge of preventive medicine made during the past fifty years, and in applications of that knowledge in social practice, has been the most cheerful phenomenon in the recent history of civilization. The new applications of physical forces—heat, light and electricity, which mankind has learned to use in its conflict with nature—have proved to be highly beneficent in the field of preventive medicine. Civilized communities have been enabled to make their water supplies, food supplies and drainage systems safe, and to contend with unexampled success against formidable pestilences, the common communicable diseases, and the bodily ills which attend urban life and the factory system."

SANITARY ENGINEERING ACHIEVEMENT

In this work of preventive medicine the sanitary engineer has borne his full share. As we read these inspiring words of Dr. Eliot our thoughts turn at once to that monumental work in sanitation carried out on the Panama Canal under the direction of General Gorgas, and with the hearty co-operation of the engineering staff. Under disheartening difficulties, and with sacrifice of personal comfort, yes, at the risk of their lives, the men labored who made the Isthmus a place fit for the white man to live, and thereby made the construction of the canal, which means so much to mankind, possible. Honor, deserved honor, has come to him who directed this splendid piece of sanitary engineering, but I desire to put on record here the appreciation of this society for the men who stood by. Is it reasonable to suppose that the engineers who did this work, who made these sacrifices, were not the highest type of men—practical idealists?

We are called iconoclast engineers, utilitarians, non-respecters of tradition, antiquity and picturesqueness. Iconoclasts? Yes; reformers usually are. Utilitarians? That, too, is an accusation that we cannot deny, but is an act less noble for being useful? Non-respecters of tradition and antiquity? Again we plead guilty, if tradition stands for error, and antiquity for decay. Destroyers of the picturesque? A general denial cannot be entered against this charge either, and in some cases, I am free to confess, too little justification can be shown for the disregard of the picturesque. This is a point I shall touch upon more fully later, but with special application to the cases cited above and similar ones, what is picturesqueness but the diseased condition of structures and their surroundings? What is this vaunted love of the picturesque, in many cases, but a selfish and thoughtless appreciation of surface appearances? Selfish and thoughtless, I say, because the few are willing to sacrifice the weal and woe, the health and happiness of the many, in order that they may feast their eyes on narrow winding streets, on quaint gables, far-reaching eaves, small, curiously leaded panes of glass. They are taken in by the surface appearance of things. But little heed give they to the squalor and dirt, the misery and sickness existing in these picturesque quarters. Who, then, is the idealist? The man probing into the sore which has so little surface indication, finding its deep-rooted seat, and skillfully using the knife, or the man who, misled by these same facts, applies a surface dressing and allows the sore to eat into the body? To the thinking man the answer is simple. Perhaps you will grant now that at least one branch of engineering, sanitary engineering, and idealism are not only not incompatible, but that they are almost inseparable. And what I have shown somewhat fully for this branch of the profession can be shown as well for the many other branches.

IRRIGATION OPENS NEW TERRITORY

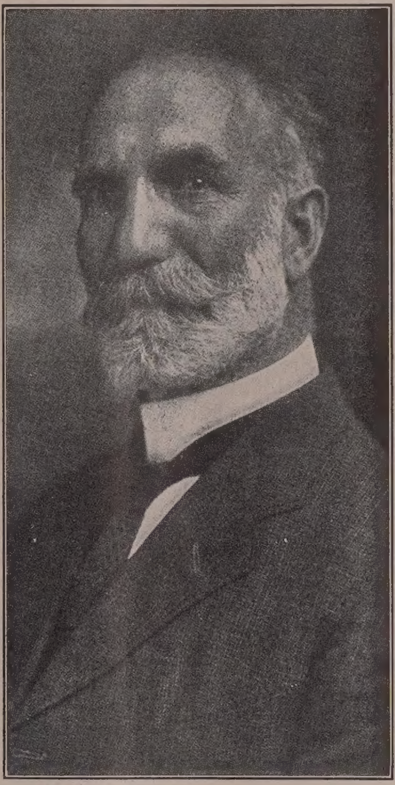
Take irrigation engineering, for instance, the possibilities of which are only beginning to be realized in this country. Is it likely that the men carrying out these works see in them but the piling of one stone upon another, the digging of so many feet of trench, the laying of so many feet of pipe? These black cast or wrought iron cylinders stand for more than this to the true engineer. He realizes that with every water or drain pipe *well laid* he is bringing prosperity and happiness, health and vigor where before existed poverty and misery, sickness and languor. Perhaps the most wonderful instance on record in modern times of the far-reaching effects of irrigation engineering is found in Egypt. In an article on the regeneration of Egypt by the former librarian at Stanford, Mr. Woodruff (now professor of law at Cornell), he unhesitatingly and justly, I think, attributes a large share of the credit for this "new birth" to the work of the English engineers. Mr. Woodruff says, "The history of the English in the administration of Egypt for the past nine years is the record of the return to health, strength and prosperity of a country that has been bled and starved almost beyond resuscitation. And yet there has been little romance in this restoration. It is chiefly a story of common sense, honesty and straightforward hard work."

But we need not turn to foreign countries to find work of the irrigation engineer worthy of commendation. Our own Reclamation Service has made a record of which we may well feel proud. Here, too, the men, with a devotion to the cause of mankind, with loyalty and steadfastness, have given a service the value of which is not yet fully recognized. They are the men of whom Chief Engineer Davis said: "Their chief tie to the service is not the matter of salary, but interest in their work and loyalty to it and the belief that they are appreciated." Again I ask, is such work destructive of idealism, are such men lacking in ideals?

RAILROADS UNITE MANKIND

In railroad engineering, think you that the men who through virgin forests and sandy deserts, through miasmatic swamps and rocky canyon, across rivers and over mountains, carried the steel bands that now tie mankind so closely together—think you that these men were engaged in an occupation likely to kill their ideals? When the final balance is struck, I warrant that the debit will not be on the side of this grand army of peace of the present, as compared with the armies of war of the past and present, for deeds of ideal heroism, self-sacrifice and devotion to duty. It seems like carrying coals to Newcastle to speak in an audience like this of what the railroads have done for all countries—for our own country especially, and more particularly for the Pacific slope. It was not so long ago when I read of the beginning of construction of the Trans-Siberian Railway which now unites the Atlantic and the Pacific on the other continent. The Cape to Cairo Railway, too, has passed through the stages of its preliminary surveys and partial construction. What centuries of fighting could not accomplish these two roads will in time accomplish. The light of civilization will be spread on the Dark Continent, and its strong rays will burst the fetters and open the prison doors of suffering men and women in Russia. Who then is destructive of idealism? The man whose works are a means, if but a humble one, of bringing his fellow beings into a direct contact with the wonders of creation, or he who, enveloped in the mantle of exclusiveness, bemoans this defiling contact?

President of American Society Denies Imcompatibility of Engineering and Idealism



PROF. CHARLES D. MARX

ROMANCE OF BRIDGE BUILDING

What bridge engineer has not been touched by the romance of his profession? What engineer has not been thrilled by Kipling's story of the "Bridge Builders," where that master hand has voiced in prose which is almost poetry the thoughts that came to the engineer as he viewed his work? "It was a long, long reverie, and it covered storm, sudden freshets, death in every manner and shape, violent and awful rage against red tape half frenzying a mind that knows it should be busy on other things; drought, sanitation, finance; birth, wedding, burial, and riot in the village of twenty warring castes; argument, expostulation, persuasion, and the blank despair that a man goes to bed upon, thankful that his rifle is all in pieces in the gun case. Behind everything rose the black frame of the Kashi bridge—plate by plate, girder by girder, span by span—and each piece of it recalled Hitchcock, the all-round man, who had stood by his chief without failing him from the very first to this last."

If I desire to show that in still another branch of engineering—the one of river and harbor improvement—there is nothing destructive of idealism, I need not go far for an illustrious example. What James B. Eads has done for the people living in the Mississippi Valley in opening up the mouth of the Father of Waters stamps him as one of the benefactors of mankind. For years he labored and fought; removed mountains of obstacles, overcame prejudice, malice and ignorance. Mr. Corthell, the staunch friend and principal assistant of Captain Eads on this momentous work, quotes him as saying. "I therefore undertake the work with a faith based upon the ever-constant ordinances of God Himself; and so certainly as He will spare my life and faculties for two years more, I will give to the Mississippi, through His Grace and by the application of His laws, a deep, open, safe, and permanent outlet to the seas."

ART AND THE ENGINEER

I think enough has been brought before you now to show clearly that engineering is not destructive of idealism. That much refuted there still remains the charge that engineering is destructive of, or at least in part responsible for, the decay of art. I propose to show that this statement also is false. Artist and romanticist appear as accusers. Again they point backward and say: "'See what the past has created; what have we that can be placed by its side?" Their eyes are blinded to the changed condition of things. They lack the sympathetic understanding of the complex problems of the life of to-day, and the materialized solution of these problems does not appeal to their idea of the beautiful. For the intelligent enjoyment and, more particularly, for the criticism of any creation, there is needed at least a fair knowledge of the underlying principles of construction, be that a work of symphony, a poem or a bridge. It is true that a symphony or poem appeals much more readily to a large audience than does a bridge or a complicated piece of machinery; yet both the latter may be as much works of art as the former, a higher degree of development of the intellect being needed, however, to see and feel their beauty. Every engineering structure is the materialized idea of its function. The ideas underlying engineering works are often ideal ones, and the works themselves therefore can be idealized. When this is done the engineering structure becomes a work of art.

In all ages that which most truthfully and characteristically embodied in itself the representation of the life and the ideas of those times was deemed a work of art. He is the artist who expresses most faithfully what we think and feel. If such representation has not been had in our century, it is not for lack of new ideas and materials furnished by science pure and applied, but for the lack of adequate assimilating power on the part of the would-be apostles of the beautiful.

THE ARTISTIC IN THE STRUCTURES OF THE PANAMA CANAL

It is encouraging to note that our own government in connection with the structures of the Panama Canal sent the sculptor, Daniel C. French, and the landscape architect, Frederick Law Olmsted, to report on the artistic character of the Isthmian structures and to make suggestions for such improvements as to them seemed desirable.

"The canal itself and all the structures connected with it impress one with a sense of their having been built with a view strictly to their utility. There is an entire absence of ornament and no evidence that the aesthetic has been considered except in a few cases as a secondary consideration. Because of this very fact there is little to find fault with from the artist's point of view. The canal, like the pyramids or some imposing object in natural scenery is impressive from its scale and simplicity and directness. One feels that anything done *merely* for the purpose of beautifying it would not only fail to accomplish the purpose, but would be an impertinence." Thus spoke the true artists.

IS IT PROFITABLE TO BEAUTIFY ENGINEERING WORKS?

Is it profitable to beautify engineering structures? Here we stand before a momentous question. If the answer be given by the engineer, or by one who holds that the status of a people is determined not merely by the accumulated wealth of the nation, the quantity of goods produced, and of articles manufactured, then it will be in the positive, ten times over. But if the man of low ideals and mercenary motives gives answer, it is likely to be an emphatic "No." This answer has been given too often in our own country, and the blame for the deep scars in the face of nature, the ugly dams and rugged cuts, must not be laid on the shoulders of the engineer. Where broad-minded liberality and far-seeing policy govern the construction of engineering works, as is the case in countries older than our own, these works stand as worthy art products of the spirit of the times symbolical of the best and highest in the life of to-day.

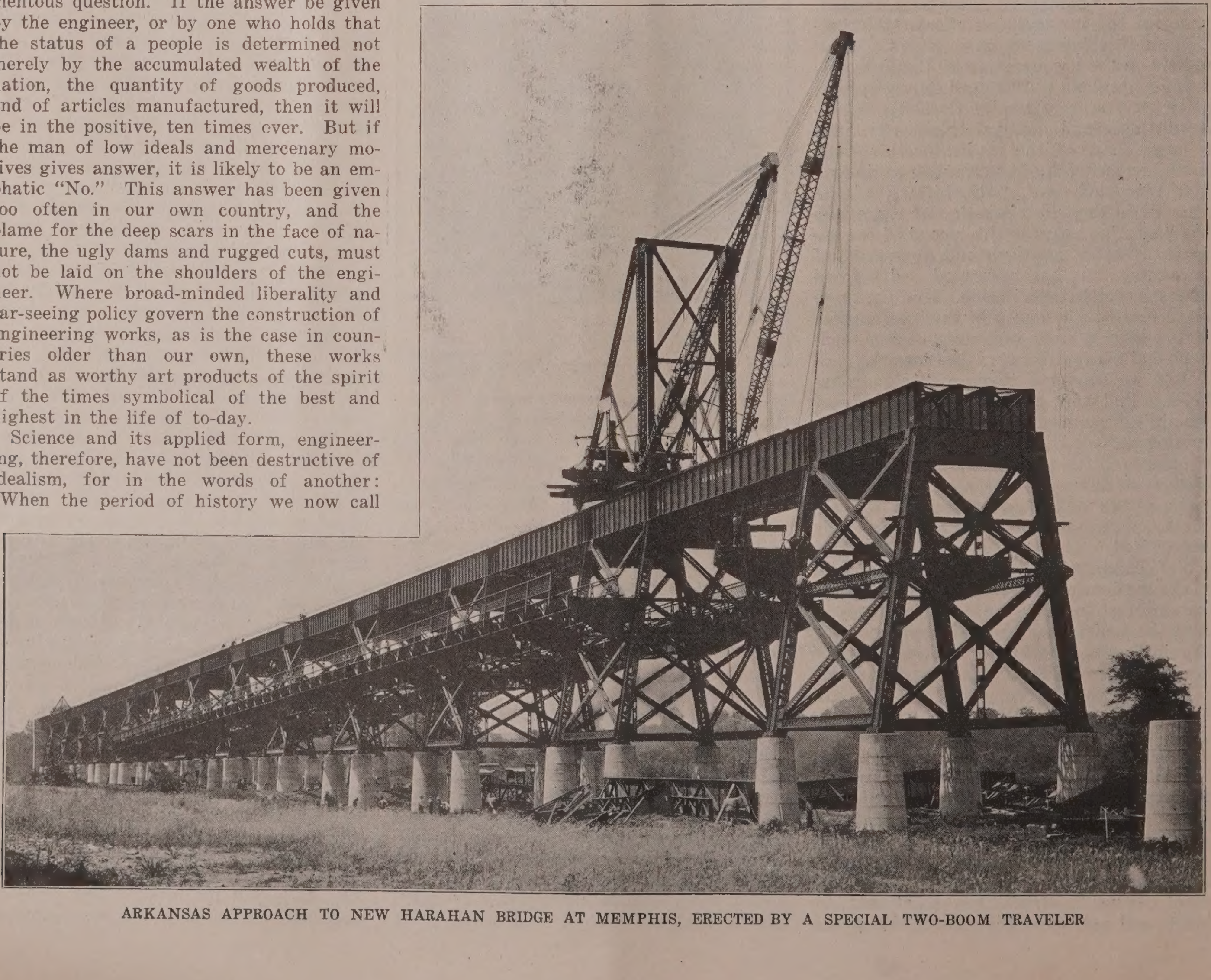
Science and its applied form, engineering, therefore, have not been destructive of idealism, for in the words of another: "When the period of history we now call modern will be rounded to completeness, all the highest and most sacred human ideals will not be lost or dimmed, but will become nearer and more real," and science has not been destructive of art or beauty. As Emerson says, "Beauty will not come at the call of a legislature, nor will it repeat in England or America its history in Greece. It will come, as always, unannounced, and spring up between the feet of earnest men. It is in vain that we look for genius to reiterate its marvels in the old arts; it is its instinct to find beauty and holiness in new and necessary facts, in the field and roadside, in the shop and mill. Proceeding from a religious heart, it will raise to a divine use the railroad, the insurance office, the joint-stock company, our law, our primary assemblies, our commerce, the galvanic battery, the electric jar, the prism, and the chemist's retort, in which we seek now only an economic use. Is not the selfish and even cruel aspect which belongs to our great mechanical works—to mills, or railways, and machinery—the effect of the mercenary impulse which these works obey? When its errands are noble and adequate, a steamboat bridging the Atlantic between Old and New England and arriving at its ports with the punctuality of a planet, is a step of man into harmony with nature. The boat at St. Petersburg, which plies along the Lena by magnetism, needs little to make it sublime. When science is learned in love, and its powers are wielded by love, they will appear the supplements and continuations of the material creation."

Arkansas Approach to Memphis Bridge Rapidly Erected

CONSTRUCTION is rapidly proceeding on the new $3,000,000 Harahan bridge at Memphis, Tenn., being built by the Arkansas & Memphis Railway Bridge & Terminal Company for use by the Rock Island lines, the Missouri-Pacific Iron Mountain system and the St. Louis Southwestern Railway. The Arkansas approach, one view of which is shown in the accompanying photograph, is now practically completed, and forms an excellent example of rapid erection of a combination railroad and highway heavy steel viaduct of standard construction.

This western approach on the Arkansas side is 2360 ft. long and will contain about 5500 tons of steel. The double-track railroad is carried on the usual type of plate girders supported on cross-girders at the steel bents. The two roadways for vehicular traffic are carried on brackets projecting from the sides of the columns at different elevations, providing the graded approach.

This bridge was designed by Modjeski & Angier, consulting engineers, Chicago, who supervise the entire construction. The special traveler was designed by the engineers of the Virginia Bridge & Iron Company of Roanoke, Va., the contractors on the western approach, and has resulted in a large saving in time and cost of erection. The contractors on the substructure are the Union Bridge & Construction Company, of Kansas City.



ARKANSAS APPROACH TO NEW HARAHAN BRIDGE AT MEMPHIS, ERECTED BY A SPECIAL TWO-BOOM TRAVELER

American Engineers Tell International Congress of Country's Contribution to World's Progress

Extracts from Eight Civil Engineering Papers Presented at San Francisco This Week by John F. Stevens, Nelson P. Lewis, F. H. Newell, Logan Waller Page, J. A. L. Waddell, J. E. Greiner, George F. Swain and Emory R. Johnson Indicate Scope and Variety of Subjects Discussed

Business Principles Should Govern Railroad Building

By JOHN F. STEVENS
New York City

THE STUDY of the conditions leading up to the contemplation of all new railroad lines involves the same general problems—whether or not the line should be built at all, and if so, where, of what character and at what cost. Balancing the safe probable income against the probable outgo becomes all important, and the study of this consideration presents a separate, distinct problem in each individual case.

In order to secure capital for the building of a new independent line, the probable results to be expected must show at least ability to earn operating expenses, taxes, fixed charges, and a sum over and above of at least twice these amounts, to be applicable to sinking fund and dividends. The consideration of the probable safe financial results, is one to which is rarely given the amount of study which the conditions demand. The path of railway planning and building in the past, in the United States, is strewn with the wrecks of the hopes and fortunes of promoters and capitalists who have been lured to disaster by unwarranted assumptions of traffic certainties, which, in most cases, a cold, careful, logical analysis made by competent, conscientious, experienced traffic men would have been clearly shown to be impossibilities. None but such men should be entrusted with the securing and preparing of such data, and no factor, great or small, which might affect this result, should be overlooked. What may be termed a house to house canvass covering all of the entire territory which the new line can reasonably be expected to serve should be made. Markets, connections with other lines, divisions of rates, probable competition, are most important factors to be carefully studied. The character of the country which the new line will traverse, and its probabilities as to future growth, based not only on its apparent resources, but on the results which experience shows have been obtained in similar sections and under similar conditions, should be thoroughly investigated.

Physical Problems

Once, however, all the necessary data have been collected, carefully sifted and summarized, and the decision has been reached that the building of the line is a necessity, that it can be fully justified, and that the proper financial support can be found, then there enter into the proposition certain problems, which, while they are largely physical, are yet of great importance; and the manner in which they are handled, in connection with the purely economic questions, may make or mar the enterprise. These problems cover the actual planning and constructing of the physical road itself, in giving it a constitution and members suited to its needs, in short, to make it the kind of tool best adapted to the work it is to do, and it is these problems that it is peculiarly the province of the engineer to solve. The nature and amount of the expected traffic, as well as the country to be traversed, are the controlling factors, the proper appreciation of which must determine the physical characteristics of the proposed line.

Broad Engineer Needed for the Problem

The economics involved in the building of a new line should be intrusted only to a man who not only is a good technical engineer, in the broadest sense of the word, but also has a practical knowledge of the intricacies of handling transportation, the best and most economical methods of maintaining railway properties, and in a general way at least, the effect which the working out of the details of his problem will have on the attracting of traffic to the line or repelling it. He should be furnished, not only with the general factors which made up the decision that the line should be built, but also with the details. This is especially true where the road will naturally enjoy a good local business. With such a line there is hardly a mile of its entire length where its character and cost of construction may not be affected by its prospective local business.

The probable proportion as between passenger and freight earnings, as well as the character of each class and their relative importance, are factors to which careful attention must be given. Ordinarily, in terms of both earnings and expenses, the freight will largely predominate, but too much prominence should not be given to that feature, as the comfort of passengers must be provided for, and while a road with easy grades and comparatively heavy curves may economically handle heavy freight, human beings will complain if hurled at high speeds over such a road. The mixture of passenger and freight traffic is a handicap which prevents the engineer from working out a perfect machine, but he must adjust his plans to meet the conditions, and not sacrifice the interests of either class entirely to the other. Unless, however, the road is to be built to compete for highly remunerative passenger traffic, the one fact alone that usually from 65 to 80 per cent of the earnings come from freight should emphasize the importance of securing the lightest grade the country will reasonably admit of, even at the expense of the introduction of somewhat heavier curvature than high-speed passenger service will demand.

Careful Reconnaissance Essential

A careful reconnaissance of all the territory to be covered by the new line—a study which will give the engineer a correct mental picture of it in all its physical features, geographical and topographical—is a very important, economical necessity. More mistakes in the essentials of location have been made, and more miles of poorly located line have resulted from the assumption of arbitrary rates of grades and curvature, and attempts to fit such standards to an unknown topography, than from any other cause. True economics demand that the engineer shall, when all data as to traffic and details of country are known to him, evolve a line of such character that will come nearest to meeting all conditions, instead of trying to force a preconceived line of certain character on the country to handle its traffic.

The engineer must remember that in the operation of the road, its financial status is, in the last analysis, like that of the individual—dependent entirely upon its income and its outgo; and these terms mean, in the case of the former (as far as freight is concerned) ton-miles (income) and train-miles (outgo), and his problem is to build a road that can handle the greatest number of ton-miles with the least number of train-miles. It does not necessarily follow that the lightest possible grade he can force through the country is necessarily the most economical one. An unnaturally light grade may involve such length of line and such enormous cost of construction (necessitating not only abnormal fixed charges, but cost of maintenance, all of which will be reflected in heavy train-mile expenses) that it will be found that a heavier grade, by reason of its shorter line, less expensive construction and better alignment, will prove, with proper adaption of power, the more economical.

Again, it is not so much what the road can earn as what it can save. Light or heavy grades are comparative terms, and it is the grade over which the business can be the most cheaply and efficiently conducted that should be adopted, regardless of its percentage. The introduction during the last few years, of a certain class of locomotive, whereby enormous tractive power is obtained without materially increasing strains on track or bridges, has introduced a different factor into, and to a great extent, has simplified the problem of gradients, especially on heavy mountain lines.

Pusher Grades Often Desirable

Another economy to which the attention it merits is seldom given is the pusher grade. The prevalence of opinion among railway operating men is against such grades, but no special reason can be given. The question comes squarely back to cardinal principles—fixed charges and train-miles. In many cases, where long stretches of non-revenue producing mileage would be forced to maintain a continuous light grade line, with abnormal expense in construction and maintenance involved, a thorough study of the value of pusher grades would surprise some engineers who have been prone to give them no consideration.

The matter of maximum rate of grade being decided, its distribution becomes a problem of importance. Economical movement of trains demands that they shall be moved, not only with as large a tonnage as time will permit, but that they shall be moved solidly for the greatest distance practicable to avoid both loss of time and cost of intermediate switching. Thus, if the proposed line is to be more than the economical length of one engine run, then the grades of each separate operating run must be worked out as an individual problem. And wherever any difference in rates of maximum grades may exist between different runs, it should be eliminated by adaptations of different classes of power, so that a continuous unbroken movement of a uniform tonnage train can be made over the entire road. When we reflect that the average daily movement of a freight car is less than one-fourth of the daily mileage that the railways are paying train and engine crews for, it becomes very apparent that the fewer inducements that are given for holding up and switching a train, the better will be the operating results.

UNBALANCED TRAFFIC

The economic adjustment of grades, in cases where the traffic is unbalanced, presents a complicated problem. Many times this question is simplified by the nature of the country, as in case of roads built to handle the products of mines, which are often situated in high altitudes. No set rules can be made to govern each case, but here is where the operating experience of the engineer, combined with his knowledge of construction and operation costs will, as a rule, produce the best results.

The effects of curve resistance, not only in the absorption of power, but in the increased cost of maintenance of track and rolling stock, are too well appreciated to need discussion here. The compensation for curvature, if properly applied, will largely eliminate the first handicap, although, as it is sometimes applied, without due consideration as to location or curve, speed and length of train, it is not of the full value that it should be. Practically each curve presents a problem which should be worked out on its own individual merits.

To what extent permanent work should enter into the construction of the line is a consideration that must be governed largely by circumstances. There are times and occasions when the building of masonry structures, steel bridges, expensive stations, etc., cannot be considered. The comparatively cheap cost of timber in some localities, and the absence of definite knowledge as to required capacity of waterways, fully justify its use in many instances. In the construction of almost every new line there are instances where the expenditure of large sums can be deferred for long periods, or until the road has, by constantly increasing earnings, fully justified such expenditures.

TERMINALS ALL-IMPORTANT

But the economic consideration which, it would seem from results, usually receives little attention, but which, without doubt, deserves very much, is the providing for proper terminals of a capacity not only sufficient for the present, but also susceptible of enlargements for future requirements. It is a safe assertion that no one cause, from a physical standpoint, contributes more to the high cost of operation or is a greater handicap in giving good service than the poor terminals of most of our railroads. If it becomes necessary to economize do it out on the line, but not at stations; and especially not at terminals proper, particularly in the area of real estate secured. And these terminals should be located as near the center of commercial and manufacturing activity as possible, especially if traffic competition exists, or is liable to exist, as is generally the case.

The field of railway promotion and building is still open, and the writer believes it will widen and become again attractive when the financial situation becomes normal, and when the general public understands and admits the community of interest which exists between it and the railways. The field is a legitimate one, but it must be cultivated on strict business principles, a few of which the writer has endeavored to point out.

City Planning—What It Is—Four Main Features

By NELSON P. LEWIS

Chief Engineer, Board of Estimate and Apportionment, New York City

THE CONVENIENCE and attractiveness of a city will depend upon four features of its plan:

1. The transportation system, or the means provided for getting in and out of the city, and for quick movement of passengers and freight from one part of the town to another.
2. The street system in and through which the daily business is done and by which the people gain access to their homes and pass from these homes to their work, recreation and amusement.
3. The park and recreation facilities upon which the comfort and health of the community are to a large degree dependent.
4. The location of public buildings, which may render the conduct of public business convenient or difficult and may give a favorable or unfavorable impression to visitors.

TRANSPORTATION

The modern city owes, in most cases its genesis, and in all cases its growth and prosperity to its facilities for internal communication and for easy access to its sources of supply and to markets for the disposal of its manufactured products. The fullest consideration should, therefore, be given to the general problem of transportation in the original planning of a city, and ample facilities to enter and leave a city are as important as those for inter-communication between the different parts of the same city. In a paper presented to the city-planning conference in Chicago in 1913 [abstracted in the Engineering Record of July 19, 1913, page 65] Milo R. Maltbie points out that the city which has the best transportation facilities by land and water is the one which will increase most rapidly and that "the city which has the cheapest, most rapid and most convenient facilities for communication between its various parts is the city, other things being equal, which has the most productive and healthful citizenship. The transportation problem is a separate subject, however, and will be referred to in this paper only in its relation to fundamental city planning.

CORRELATION OF TERMINALS

Seaport cities have been slow to appreciate the need of the proper correlation, if not the unification, of rail and water terminals. Railroad terminals are often planned as if there were no other means of transportation. Shipping terminals are likewise designed as though railroad connections were of little or no importance. Only recently has the problem of port organization attracted the attention which it deserves. Too much emphasis cannot be laid upon the need of keeping in mind from the beginning the proper connection of railway lines with each other and with the terminals for water-borne traffic.

Railway and waterfront terminals, though neglected in the original planning of a city, can be provided or enlarged notwithstanding the fact that the general city plan did not contemplate their need, even though the cost of doing so will be very great; but the handicap placed upon the intra-urban transit system through an inadequate and badly arranged street system can never be fully overcome. It is impossible, also, to anticipate just how a city will grow or what transit lines will be required first.

WIDE STREETS FOR TRANSIT LINES

In great cities elevated and underground railways may be required on certain streets; these, however, will be few and will be confined to the most heavily traveled routes on which the surface lines will have preceded them. A street which will accommodate a double-track surface railway and leave room for vehicles between the cars and the curb will also accommodate a two-track underground railway with station platforms, while the difficulty and cost of constructing rapid-transit lines in city streets are so intensified in narrow streets that the provision of adequate street widths for transit purposes is fully justified.

By far the greatest mileage of railway lines in any city will be the surface tracks in the streets, operated by the overhead trolley system. The inflexibility of the surface railway in comparison with motorbuses and other free-wheel vehicles necessitates a greater roadway width for their accommodation, and unless there is room for other vehicles to pass between the cars and the curb, congestion will result. The author believes that any street which is likely to be called upon to accommodate surface railway tracks should be given a width of not less than 70 ft., while in the case of main traffic arteries where elevated or underground railways may also be required, such width should in no case be less than 80 ft.

STREET SYSTEM

There have been a few cases where important cities have been planned as a unit; where the administrative center, the commercial, industrial and residential districts, the lines of transportation and their terminals, have been laid out after careful study to meet conditions which could be confidently expected or to a large degree controlled. Washington is one of the most notable instances of such city planning. The city planner usually finds, however, that the beginning has already been made, a beginning which may prove a serious handicap or may, though less frequently, be an admirable nucleus for the larger plan. Most old cities have simply grown with very little planning. Comprehensive plans, where such have been prepared, are of comparatively recent date and have had to adapt themselves as well as might be to the older portions of the towns as they were, and make designs for sections not yet developed conform with the haphazard growth which had already taken place. Plans of such cities, therefore, commonly consist of a number of separate designs more or less unrelated to each other, abutting upon the confused and uneconomic system of streets in the old town, which in most cases has persisted as the actual center.

STREETS IN UNDEVELOPED SECTIONS

In every city, however, there are large areas not yet developed and not even planned, where opportunities are presented to design a street system, the different parts of which will be properly located with respect to each other and to such modification of the system of the existing town as may ultimately be carried into effect. Too often these undeveloped sections are planned as if they were so many different urban areas unrelated to each other or to the original city, and too often the obvious blunders of the older sections are repeated in the new additions.

In nearly all cases where a street plan is to be devised, whether it be for a large area which can be treated almost as an entire city in itself, or for a smaller tract contiguous to the built-up portion of an important city, the first essential is an accurate plan of the existing roads showing their widths and the buildings fronting upon them. The old highways which serve to connect villages or centers of population have a good excuse for existence and serve a useful purpose; they lead where people want to go and are likely to be fairly direct. Their alignment may be somewhat faulty, their grades excessive in some places, and their widths inadequate in view of the fact that they will naturally become the main lines of traffic for the urban district which will include them. With such straightening and widening as may be deemed necessary and such changes in line as will reduce excessive grades, these old roads will be the logical basis of the street plan which is to be prepared. When they have been platted, it will be obvious that additional roads will be needed, some to establish cross connections, others to give greater directness to the roads traversing the entire territory, others as bypasses around groups of buildings so located as to render the widening of some portions of the old roads unduly expensive, and still others to furnish lines of main drainage along the valleys through which the lateral sewers and subsidiary trunks must ultimately find their outlets.

PRIMARY STREETS

While no one can predict with any certainty the precise manner in which any city will grow, the purpose of the preliminary design is to establish lines of least resistance which future development is quite likely to follow. The streets laid down in this plan will probably become the main arteries of traffic. They will divide the territory into a series or irregular figures having three, four or more sides, which sides may be a quarter or a half a mile or more in length. These areas must be subdivided by secondary roads in the location of which regard should be paid wherever possible to property subdivision, to the possibility of some of them developing into main traffic roads, and to the avoidance of awkward junctions with the main roads already laid down, which would result in confusion of traffic. It is difficult to say how wide the primary and secondary roads should be made. The Royal Commission on London Traffic in its report, made some years ago after an exhaustive study, suggested the following widths: Main avenues 140 ft., first-class arterial streets 100 ft., second-class arterial streets 80 ft., third-class streets 60 ft., fourth-class streets 40 to 60 ft. This scale of widths may be somewhat over-generous and might involve unnecessarily great cost.

Lastly will come the minor streets which will serve almost entirely for access to dwellings. Their alignment and grades are of little importance. The chief concern is that they should be so laid out as to furnish ample light and air and discourage, if not prevent, a too intensive development with rear buildings in case the city ordnances do not prohibit this menace to health and decent living. To plan far in advance the precise location of these minor streets is not necessary, if it be not unwise. There is no reason why a street which is to be devoted to private residences should be long and straight. Among the most attractive features of a city are small residential areas treated in a distinctive way, each with a character of its own, which the visitor stumbles upon with agreeable surprise. If these minor subdivisions are planned at different times or by different persons, this variety in treatment is more likely to be realized. The important thing is that the skeleton should be created first.

While directness is desirable in the main and even the secondary streets, it does not follow that such streets should be perfectly straight; in fact, straight streets are seldom interesting. Neither need circumferential or curved streets be laid out with perfect symmetry. In studying a plan the slightest departure from symmetry is noticeable, but on the ground it cannot be detected. One can ride or walk along a boulevard following a sweeping curve and be unconscious of the fact that its radius is frequently changing.

PARKS AND RECREATION FACILITIES

The city park, located, acquired and developed as a public playground, is a modern idea and is a result of the steadily increasing size of our cities. The park system, however, is usually of haphazard growth and its place as a part of the city plan is not yet fully appreciated. It is obvious that the needs of a city for open spaces cannot be anticipated to the same degree as can its requirements for transportation and a street system. Estimates have been made of the percentage of a city area which should be devoted to parks and of the proper number of people to each acre of park lands, but the needs of an urban community cannot be determined in this manner. The compactly built city where the individual dwellings have no open spaces about them, where the streets are narrow and where the average number of occupants to each dwelling is large requires a greater park space per capita and a larger space in proportion to the area of the city. On the other hand, where dwellings are detached and each has its garden, where the streets are broad and lined with trees, the need of parks is much less. The industrial town or district has a far greater need of such reservation than does the residential town or district, while it usually has less.

It is frequently argued that it is folly to select and acquire park reservations until the actual need of them is imperative, that they can then be placed where that need is greatest, that the additional expense of their acquisition at the enhanced value, and on account of the destruction of buildings, will be less than the carrying charges and loss of taxes, and that, unimproved parks being of little value, their development at great cost is likely to be undertaken prematurely if purchased before they are actually needed. There may be some instances where this has proved to be the case but they are exceptions rather than the rule.

THREE CLASSES OF PARKS

The argument that a park should not be acquired unless it is to be improved at once is an unsound one. Public pleasure grounds may be divided into three classes—the wild park where the natural conditions remain undisturbed as far as possible, the developed park where by skilful treatment and planting such natural features as meadows, woods and lakes are combined, and the formal park which is more in the nature of a garden. A city park if of sufficient size may pass successively through these stages. There is no greater boon to the city dweller than the opportunity to frequent a place where nature has been interfered with to the least possible degree. A few walks or roads through the woods are all that is necessary in the way of improvement. As such parks become more frequented and as their natural beauties are more likely to be destroyed, a greater degree of development with more strict policing may be required and gradually the wild park becomes a developed park, while portions of it may in time be treated as a formal garden.

The land which will in time make the best parks will often have been passed over by the real-estate developer as unsuited to his purpose—precipitous hillsides where the cost of development would be prohibitive, creek bottoms or meadows which may be subject to periodical flooding, wooded tracts somewhat off the lines of transit, even marshes which are unfit for development until thoroughly drained—any or all of these present great opportunities for effective and economical development into parks. Their actual value is small, the return from them in taxes is insignificant, and to carry them until their development is needed will not be a serious burden.

The planning of a park system should receive as careful study as the planning of a transportation or street system, and it is just as much a part of a comprehensive city plan. While it is obviously impossible to formulate as definite a plan for parks as for streets, there must be some relation between them, not necessarily an economic relation, not even a ratio between the total area of parks and that of the city, not a maximum and minimum of size nor any standard as to their shape. It may be said that in planning a city the park reservations should be governed by the street system. While this is true, the streets should also bear some relation to the park system.

PARKS SHOULD BE CONNECTED

In planning a system of parks provision should be made for connecting them. Experience seems to show that streets more than 100 ft. in width rarely develop into business thoroughfares. Consequently, if those which are to serve as park connections or parkways are given a width of from 120 to 150 ft., business will be likely to avoid them, while such width will be sufficient to provide certain park features when the time comes for their development.

The judicious selection of the park areas will require skill and judgment, and the advice of a competent landscape engineer or architect should be secured. To defer this until the time comes for actual development is unwise. Expert knowledge as to the possibilities of the different park sites is worth far more than skill in adapting an unsuitable site to the desired purpose.

PUBLIC BUILDINGS

The designation "public buildings" is commonly used as applying only to those in which the business of the Nation, State or city may be conducted. In their relation to city planning there are many others which can properly be called "public buildings," not only libraries and museums, but also schools, penal and charitable institutions, markets, hospitals, police and fire houses, baths and structures connected with water supply and drainage. They may also include churches and buildings used for amusement and entertainment under private as well as public management, and railway stations and terminals, lighting and heating plants, financial institutions, etc.

The effective grouping of public buildings to create civic centers has received much attention of late and appears to have become somewhat of a passion in American cities. Numberless towns, great and small, and even villages, are now studying this problem. The aim of city planners and architects is usually to locate public buildings, whether isolated or in groups, so that each building shall be a single unit, even though it may bear a certain relation to others. Each building is given a site of its own with due regard for those of its neighbors.

[In the next issue the Engineering Record will abstract the remainder of Mr. Lewis' valuable paper, which goes into more detail regarding the working out and financing of the city plan, and closes with an appeal to the engineer to take a broader part in the work.—EDITOR.]

Does Irrigation Pay?

By F. H. NEWELL
Formerly Director, U. S. Reclamation Service, Washington, D. C.

THE ENGINEER who plans and builds irrigation works sometimes forgets that on the back of the farmer the entire superstructure of the development rests. Landowner, investor, promoter, State and nation, all look to the farmer to justify the effort made in irrigation development. With a wider view of his opportunities and responsibilities, the engineer is beginning to appreciate the fact that he has a duty in seeing to it that the works are planned and built with primary consideration of the farmer's need and personality. We have given more thought to the legal status of the irrigated land than to the ability of this land to produce crops.

FARMING AS A BUSINESS

The Department of Agriculture, through its Office of Farm Management, has begun to bring together results of careful studies, analyzing the condition of the farm from a business standpoint and bringing out clearly the fact that the average farmer obtains for his investment and labor about 5 per cent on the capital involved and an earning about equal to the wages of a day laborer. If he employs farm labor, the cost, under prevailing conditions of high prices and inefficiency, may eat up a great part of these scanty earnings. These considerations of cost and returns from the irrigation farm are fundamental in any discussion of the economic advisability of irrigation, and it may be said that the study of irrigation farming as a business should be a part of the irrigation engineer's duty as well as that of the promoter and investor.

The economic importance to the nation of the development of irrigation is best illustrated by the fact that the crops produced under irrigation in 1909 aggregated in value over $180,000,000, or an average of $25 per acre irrigated. The total amount of money then invested in the various irrigation enterprises was over $300,000,000. These irrigation systems were by no means complete, and the lands were not all fully developed. If we should throw out of consideration the farms on which irrigation had just been begun, or which were not brought up to fair condition of cultivation, the average crop production would be much larger. For example, in the State of Washington where the lands were more carefully handled, and largely in fruit, the average was nearly $50 per acre.

THE INVESTOR

The success of the promoter and of the investor whom he interests in the work is not merely a personal affair; it is one in which the State and nation may take a proper interest, as leading to a larger development and use of the otherwise untouched resources of the commonwealth. It is a matter of public importance that the investor be shown that there exist fair and safe opportunities for profitable use of his money, in storing the floods and in diverting the otherwise waste waters to lands, which, without this added moisture, are unproductive.

In the case of irrigation bonds, for example, it may be necessary, in order to make these more attractive to the investor, that some of the States safeguard these to a larger extent than in the past, not only by throwing added protection of law about the bonds, but also by going still further and adopting methods which may be comparable to those of the pure food laws, or so-called blue-sky enactments.

In many instances the lands have been sold to newcomers, who, with more enthusiasm than capital, have paid out their last dollar in making a first payment and who have agreed to make deferred payments at an interest rate which perhaps originally was 8 per cent, but has been gradually raised to 10 or 12 per cent, or even more. This results in a burden which cannot possibly be carried by the ordinary tiller of the soil, particularly under pioneer conditions. It is these heavy interest charges on land purchases which are causing the greatest distress in the irrigated region. Moreover, the irrigators are usually land poor, in the sense that each man is attempting to handle more land than he can fully utilize with the labor and capital available, and is paying the heavy interest charges for this excess land, these eating up all possible profits.

Investigations made show that throughout the arid region the prices for undeveloped land which is susceptible of irrigation have ranged, as above stated, often, from $50 to $100 per acre, the purchases being usually made on installments, with about a fifth or a tenth down and the balance in from 5 to 10 yr., and at interest rates rarely as low as 6 per cent and more often at 8 per cent and upwards.

The taxes on these lands are necessarily large, because the country is in a pioneer condition. Everything must be done; roads must be built, schoolhouses erected and provision made for county and other officials. Everything is new and untried, and there is general lavishness in these matters, such as accompanies an influx of population. In the case of homestead land for which patent has not been issued, taxes usually cannot be levied on these lands, but the improvements may be assessed. The valuation is usually low, being a half, or even much less, of the sale price, but the tax rates may run as high as 2 per cent, or more, on this valuation.

The large expense, however, on the raw land, after the purchase price, is that of leveling and subduing the soil. In some favored areas where the surface has not been cut by winds and rains and where there is little vegetation the cost may be as low as $10 or $15 an acre. In other cases, such as on the rich alluvial soils near Yuma, Ariz., the removal of the heavy growth of cottonwood and willows and the bringing of the surface to proper level may cost $50 an acre, or even more. This cost, however, is largely that of the labor of the owner himself and usually requires little cash outlay. The cost of improvements, equipment, stock, feed, seed and trees for a 40-acre farm may range from $2,975 to $4,520.

FARM RETURNS

A study made by the Office of Farm Management of the Department of Agriculture as to what the farm contributes directly to the farmer's living shows that of 483 families in ten representative agricultural districts, the average annual value of the food, fuel, and use of the dwelling in families of between four and five persons is between $400 and $500 per family, averaging a little over $90 per person. In the estimates of the returns from the farm, it is assumed that the owner is entitled to 6 per cent interest on the true value of the investment which he has made. Returns from southern Utah relate to sixty-nine farms, which are fairly representative of conditions throughout the arid regions where the pioneer stage has been passed. The average size of these sixty-nine farms was under 50 acres, and the crop area about 30 acres. The average capital invested was $9,000, or, in round numbers, $175 per acre, including all improvements. The receipts were slightly under $1,500, and out of these were paid a little over $600 for expenses, leaving a net farm income of nearly $900, of which the labor income was figured at a little over $400, leaving, in round numbers, $500 for the earning of the investment and of the farm itself.

Taking out of the sixty-nine farms a group of thirty, which are devoted mainly to fruit and the raising of sugar beets, we have an average size of 60 acres, of which a little over 40 acres are cropped. The capital invested is a little under $12,000 and the receipts approximately $2,000, with an expense of $950, leaving a farm income of about $1,000, of which the labor income is something over $600.

With the energy and thrift which are necessary for success in almost any line of endeavor, the farmer on irrigated land has the possibility of increasing his profits to a large degree, and with greater assurance of continued success than in many other enterprises. He is sure of a home and food for the family, and, with the comparatively dense settlement of an intensively cultivated region, he can enjoy many conveniences, such as graded schools—and often electric light and power. He also has the opportunity to secure constant and increasing profits, dependent almost wholly upon his initiative and strength.

The question of increasing the profits is one which, as in almost any other business, is dependent, first, upon the capital available, and, second, upon the skill with which this is used. There are certain limits, however, which define the size of the individual business. In the case of ordinary farming in the East, it has been found, for example, that about 200 acres, representing an investment of, say, $20,000, is the most advantageous; the extent of land and amount of capital being most nearly adapted to the strength and ability of the good farmer. Beyond this limit, it is necessary to employ hired labor, and often at a loss.

Economic Factors All-Important in Rural Highways

By LOGAN WALLER PAGE
Director, U. S. Office of Public Roads, Washington, D. C.

THE highway engineer should be able to determine what to build and where to build it, as well as how the building is to be done, and he should bear in mind that as much waste is likely to result from improving the wrong roads or employing wrong types of improvement as from using faulty materials or methods in making the improvements. It seems well to consider briefly, therefore, the extent to which determinations of each character may be rationalized.

The only reasonable basis for determining which of perhaps a great number of public roads in a community should be improved, or the order in which improvements should take place, is public convenience. In order to make each improvement add the maximum amount to the convenience of the public, however, it is necessary that the engineer who plans the improvements shall have a comprehensive understanding of the economic and social relationship which exists between different parts of the community under consideration and also the effect which different roads, if improved, would have in making this relationship more advantageous.

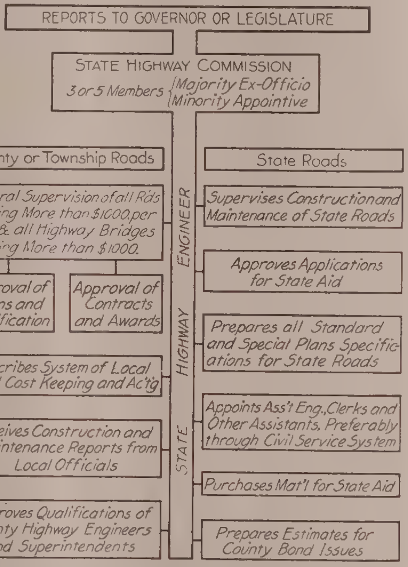
PLAN MODEL SYSTEM

In order to gain a comprehensive understanding of this kind it is usually necessary for the engineer to prepare a plan showing the various highways in proper relation to each other, and showing also how population and industries are distributed. The amount and character of traffic using each important road, or which would use an improved road having the same location, may be estimated by means of traffic counts or otherwise, and should be shown on the plan.

With such a plan before him, it is practicable for an engineer to lay out an intelligent system of improved highways which would accommodate the entire community, and to assign relative weights to each unit of the system according to its importance. This system would serve as a model toward the development of which all road improvement work should be directed, but which might be readily modified to meet the exigencies arising as the system developed.

ECONOMIC CONSIDERATIONS

The proper type of improvement for any particular road ordinarily depends for the most part on purely economic considerations. The principal factors which affect the economic efficiency of an improved road and upon which economic comparisons should be based are: First, cost of construction; second, cost of maintenance; third, amount and character of traffic, and fourth, the average unit cost of hauling before and after the improvement is made. If these factors be all intelligently considered for each of the types of any ordinary road, it is apparent that the most economical type in theory may be readily selected.


REPORTS TO GOVERNOR OR LEGISLATURE
STATE HIGHWAY COMMISSION
3 or 5 Members
Majority Ex-Officio
Minority Appointive
STATE HIGHWAY ENGINEER
County or Township Roads
General Supervision of all Rds Costing More than $1000 per Mile & all Highway Bridges Costing More than $1000.
Approval of Plans and Specification
Approval of Contracts and Awards
Prescribes System of Local Road Cost Keeping and Ac'tg
Receives Construction and Maintenance Reports from Local Officials
Approves Qualifications of County Highway Engineers and Superintendents
State Roads
Supervises Construction and Maintenance of State Roads
Approves Applications for State Aid
Prepares all Standard and Special Plans Specifications for State Roads
Appoints Ass't Eng., Clerks and Other Assistants, Preferably through Civil Service System
Purchases Mat'l for State Aid
Prepares Estimates for County Bond Issues

SCOPE OF MODEL STATE HIGHWAY DEPARTMENT AND DUTIES OF ENGINEER

The first factor, cost of construction, can usually be satisfactorily estimated for any particular road, when the conditions which affect the availability of materials, the character of labor, the prevailing gradients, etc., are understood.

The second factor, cost of maintenance, is dependent on the character of material used, the volume and character of traffic, and the climatic and topographic conditions which affect the road under consideration. This array of variables, especially when it is considered that traffic conditions are constantly changing, makes the cost of maintenance appear at first glance almost indeterminate. For most types of road improvement, however, the effect of these variables can be estimated within reasonably close limits from the data already available, and the Office of Public Roads is now working in co-operation with State highway departments and other interested persons in an effort to make these data more nearly complete. It is hoped that within a short time the information which is being collected can be so reduced and correlated that the cost of maintaining any particular type of improved road, under any given set of ordinary conditions, can be estimated with a very satisfactory degree of accuracy.

The third factor, amount and character of traffic, has its principal importance, from an economic view point, in the effect which it has on the cost of maintenance.

The fourth factor, average unit cost of hauling before and after the improvement, varies very slightly for different types of improved roads, provided that they are all equally well maintained. The real economic justification for improving any road hinges on this matter of reduction in the cost of hauling, however, and it, therefore, deserves the most careful consideration. If the unit cost of hauling before and after the improvement, and the total volume of traffic using the road are known, the total annual saving resulting from the improvement can evidently be estimated; and, if the improvement is to be justified economically, this total annual saving must be sufficient, after all costs for maintenance and repairs are deducted, to pay a reasonable interest on the original investment. To determine what type of improvement will return the largest net rate of interest on the original investment is the sole purpose of making an economic investigation.

STATE CONTROL DESIRABLE

If a model system of highways has been previously worked out, and the importance of each unit in the system has been properly weighted, it is apparent that the investigation for determining the proper type of improvement to employ on each road will be greatly simplified. It is also apparent that the more comprehensive this system can be made within reasonable limits, the less will be the duplication of work required and the greater will be the possibility of securing satisfactory results through efficient organization. The State is therefore much better circumstanced for planning and supervising road improvement work than are any of its political subdivisions. This is evidently true, even though the officials controlling road work in the subdivisions are as honest and intelligent as those in the State organization.

The chart shown herewith is intended to illustrate the scope of a model State organization and is based on several existing ones which are at present accomplishing very satisfactory results. It is evident that with an organization of this kind the experience gained and data collected in each section of a State can be turned to the greatest possible advantage in every other section.

ORGANIZATIONS ARE IMPROVING

There are now forty-two States out of the total of forty-eight which have established highway departments of one kind or another, and the organizations under which these departments operate are being constantly revised and improved. This shows that the public is awakened to the advantages to be gained by having all highway work done under a scientific and comprehensive organization. There is also unquestionably a growing public demand for quantitative assurance that every dollar levied for the purpose of highway improvement is being spent to the best possible advantage, and in order for the engineer to meet this demand he must be in a position to analyze the factors which affect the economic efficiency of improved roads and reduce his findings to a more or less rational quantitative basis. The general method of procedure necessary to accomplish this has already been outlined.

Alloy Steels Economical for Long-Span Bridges

By J. A. L. WADDELL
Consulting Engineer, Kansas City, Missouri

THE FIRST actual use of nickel steel in bridge work resulted from experiments by Gustav Lindenthal, of New York, in 1903, when nickel-steel eyebars were employed in building the Queensboro bridge. The International Nickel Company financed an extensive investigation by the author into the economics of nickel steel for bridges, begun in 1903 and continued for three years. The results appeared in the *Transactions* of the American Society of Civil Engineers in 1909.

This investigation proved that nickel steel is in every way a suitable metal for the manufacture of bridge superstructures, being just as reliable as carbon steel and from 50 to 70 per cent stronger. The correctness of this statement is proved by the fact that it has been used in the Manhattan suspension bridge at New York, the St. Louis municipal bridge and the new Quebec bridge.

Results of Experiments

The author found by his experiments that it is perfectly feasible to produce commercially an eminently satisfactory nickel steel for bridge work having a minimum elastic limit of 60,000 lb. per square inch, a minimum ultimate tensile strength exceeding 100,000 lb. per square inch and an elongation in 8 in. of 15 per cent. The actual cost per pound for this metal, delivered at the bridge site, as compared with ordinary carbon bridge steel, he figured, should not be more than 1.5 cents.

Unfortunately, however, the steel makers and bridge manufacturers have for years refused to guarantee for nickel steel an elastic limit of more than 50,000 lb. per square inch, and they have asked an excess pound price of from 1.5 to 2.0 cents. The excess price per pound for the St. Louis bridge was 1.65 cents. If there were anyone available to unload rejections upon, as there is in the case of carbon bridge steel, the steel makers would quite willingly quote more reasonable figures for nickel steel; but the constant dread of being left with a large lot of unsalable alloy steel on hand militates against their so doing. It is only by having engineers create a large demand for the alloy, thus initiating competition in its production, that a reasonable unit price for it can be established.

Mayari Steel Tests for Memphis Bridge

The Pennsylvania Steel Company has obtained control of an iron mine containing a small percentage of nickel, and is, consequently, able to place upon the market a low-grade nickel steel at a reasonable excess cost above that of carbon steel. This steel has been denominated by its makers "Mayari steel." It is a natural alloy of nickel-chromium steel, containing from 1 to 1.5 per cent of nickel and from 0.2 to 0.75 per cent of chromium, with sulphur below 0.04 per cent, phosphorus below 0.03 per cent and manganese as desired. The carbon range is from 0.03 to 1.5 per cent, depending on the use of the steel. The ore comes from a deposit of some 25,000 acres at Mayari in the province of Oriente on the island of Cuba. It is estimated that there are 500,000,000 tons of this ore in sight.

Mayari steel is made only by the Pennsylvania Steel Company and the Maryland Steel Company. Like other nickel steels, it offers greater resistance to corrosion than the ordinary carbon steel. The following extracts are from a letter to the author written by J. V. W. Reynolds, vice-president of the Pennsylvania Steel Company.

TABLE 1—RESULTS OF TESTS OF PLATES OF EXTREME THICKNESSES

Thickness, in.	Tensile Strength, lb.	Elastic Limit, lb.	Elong. in 8 in. Per Cent	Reduction of Area, Per Cent	Chemical Elements			
					C Per Cent	Mn Per Cent	Ni Per Cent	Cr Per Cent
1½	99,600	64,660	17.5	41.9	.29	.77	1.36	.31
1¼	94,300	62,270	18.0	33.6	.28	.75	1.41	.37
1½	98,820	63,080	17.0	34.7	.28	.72	1.49	.49
⅞	90,040	55,270	21.0	45.5	.28	.67	1.57	.31
1⅛	91,550	62,210	18.5	46.8	.30	.66	1.41	.40
¾	94,060	56,030	18.5	47.1	.27	.61	1.42	.33
1⅜	90,300	57,540	19.0	53.6	.29	.71	1.53	.39

"Our principal experience on Mayari steel in bridge work has been in connection with the manufacture and fabrication of the large bridge which is to span the Mississippi River at Memphis. On this bridge alternate quotations on carbon and alloy steel designs were submitted. We quoted on the basis of using a steel made from the Mayari ore. By a selection of this ore steel can be produced with a uniform nickel content which may be varied at will between quite wide limits. It has been found, however, that a content of approximately 1.40 per cent is sufficiently high for bridge steel for most purposes. The steel is normally produced with only the usual additions in the open-hearth plant, although usually a small amount of chromium is added.

[The accompanying tables give the results of typical tests of large-sized angles and of plates. It will be noted that the results are well above the specified values of 85,000 minimum for tensile strength, 50,000 for elastic limit, 1,600,000 divided by tensile strength for elongation in 8 in. and 30 per cent for reduction of area.]

"The phosphorus in all these heats will average less than 0.02 per cent and sulphur averages about 0.03 per cent, the specified limit for each being 0.04 per cent, with an allowance of 25 per cent for check analysis of the finished material. In the specifications changes in the elongation and reduction of area are allowed for steel running over 1 in. thick.

"Below (Table 3) are given the specifications for full-size eyebars and the results of a test on a sample 14 x 123/32-in. bar.

"It has been our experience that this alloy steel works quite as well in the shop as any other steel with which we are familiar, making due allowance, of course, for the increased toughness. We find that it is easier to work than a 3¼ per cent nickel steel.

TABLE 2—RESULTS OF TESTS OF LARGE SIZE ANGLES, FROM 8 x 6 x 1 IN., TO 8 x 8 x 1⅛ IN.

Tensile Strength, Lb.	Elastic Limit, Lb.	Elong in 8 in., Per Cent	Reduction of Area, per Cent	Chemical Elements			
				C Per Cent	Mn Per Cent	Ni Per Cent	Cr Per Cent
95,580	64,700	16.8	45.5	.36	.62	1.27	.36
91,400	60,130	19.5	44.4	.32	.68	1.45	.44
95,400	62,300	18.0	46.7	.34	.75	1.51	.38
94,400	54,300	17.0	50.4	.35	.71	1.48	.43
93,240	55,300	21.5	51.3	.34	.75	1.37	.43
96,740	60,540	16.3	43.3	.32	.75	1.49	.40
98,420	61,060	17.0	48.9	.37	.78	1.31	.42
91,700	56,960	19.0	56.3	.31	.68	1.45	.44
94,180	58,130	20.5	51.5	.30	.77	1.48	.47

"It is difficult to give an exact extra which we would charge for rolled sections of Mayari steel over the market price of similar sections of carbon steel. We do not expect, however, that it will be necessary at any time to charge an extra of more than one cent per pound. The excess price for manufactured bridges depends upon so many circumstances that it is almost impossible to give any figure. It will vary greatly as the relative proportions of carbon and Mayari steels in the finished bridge are varied.

"With regard to quantity, we expect shortly to be in a position to produce 18,000 to 20,000 tons per month of Mayarí steel shapes, if necessary; thus, even for the present, it is safe to say that we can meet any reasonable demand."

Electric Steel Production

The following extracts are from a letter by W. R. Walker, assistant to the president of the United States Steel Corporation:

"Although the electric steel process is a comparatively new one, being only ten years old, nevertheless there are in operation about 130 electric furnaces in this country and Europe which are making high-grade steels commercially. This steel has proved to be of such excellent quality that it is rapidly displacing crucible steel. It is also being used in seamless tubes, wire, sheets, ship angles, rails, thin armor plate and especially tools.

TABLE 3—SPECIFICATIONS FOR FULL-SIZE EYEBARS

	Required, Lb. Minimum	Obtained, Lb.
Tensile strength ...	80,000	88,200
Elastic limit	47,000	51,700
Elongation in 20 ft.	10 per cent	12.7 per cent
Reduction of area..	..	42.0 per cent

"In 1909 the steel corporation began the operation of a 13-ton electric furnace at the South Chicago plant of the Illinois Steel Company, and in 1910 began the operation of a similar furnace at the Worcester works of the American Steel & Wire Company. We have made about 10,000 tons of rails, which are now in track. Up to this time none of our electric steel rails have broken in service—even those located in the far Northwest during the very severe winter of 1912.

"Although the electric furnace at Worcester has not been in operation for some time, due to commercial reasons, the furnace at South Chicago has operated almost continuously ever since its installation, and is now employed in making alloy steels, such as nickel-chrome, chrome-vanadium, high-silicon steel, etc. From these facts I think we can safely conclude that electric steel is no longer an experiment and that its quality is equal to the best made by any other process."

Aluminum and Vanadium Steel Possibilities

In March, 1914, the author published in the *Proceedings* of the American Society of Civil Engineers a paper on the possibilities of the use of high-alloy steels. Figures and diagrams were given showing that in simple long-span structures there is an immense saving in weight of metals by using alloy steel instead of carbon steel, also that the rate of saving diminishes gradually as the elastic limit of the metal increases. The saving of material for cantilever bridges, while not so striking, is still most apparent.

Concerning rivets for bridges built of high-alloy steel, it is a foregone conclusion that the ratio of the strength of the alloy-steel rivets to that of carbon-steel rivets cannot be as great as the corresponding ratio of strength of plate-and-shape alloy steel to that of plate-and-shape carbon steel. On this account in high alloy steel bridges it will be necessary to use proportionately either more rivets, or greater diameters, or both.

There appears to be a great possibility in the use of aluminum as an alloy for bridge steel; but, so far as the author can determine, very few experiments in aluminum steels have yet been made, hence the possibility is more or less hypothetical.

The possibility of obtaining a good high-alloy steel for bridges by the use of vanadium appears to be almost a certainty; but the highest elastic limit and ultimate strength which can be obtained on a commercial basis by the use of that element cannot be determined without making some elaborate and exhaustive experiments.

[The foregoing abstract omits the details of the author's discussion of nickel steel and vanadium steel, and of comparative costs and diagrams, because of space limitations. Much of that matter has already been printed in the papers and discussions of the American Society of Civil Engineers.—EDITOR.]

Overloads Allowed in Operating Railroad Bridges

By J. E. GREINER

Consulting Engineer, Baltimore

THE PREVAILING practice among the majority of railroad companies is to design their bridges for Cooper's E60 standard loading with the American Railway Engineering Association's standard specifications as a basis. Structures designed in accordance with these standards will carry an overload of 50 per cent in regular service at unrestricted speed, and a much greater overload occasionally, or even regularly, at restricted speed, without impairing their safety. This 50 per cent overload means that these bridges are sufficiently strong to carry Cooper's E90 loading, and the modern actual service types of locomotives equivalent in their effects are given in the accompanying table.

These are the increases in rolling loads anticipated by those railroad companies which build what are known as E60 bridges; and an examination of the weights of locomotives in the table, with wheel bases as they exist to-day, will undoubtedly suggest a strong feeling of the physically impossible, unless all present standards of roadbed, gage of track and side and overhead clearances are abandoned and the railroads are practically reconstructed. Those railroads, therefore, which are making provision for the physically impossible in the way of rolling loads are surely building strong enough to take care of whatever is possible in this respect, and they should have no fear that their bridges will not carry all the loads which can ever pass over them.

When we consider that even if such excessively heavy types of locomotives are constructed and placed in operation, without changing standard gage or clearances and without reconstructing our railways, their operation would most assuredly be confined to high grade divisions, and they would not be regularly operated on low grade divisions. If such is the case, then those conservative roads which are designing their bridges for Cooper's E50 class of loading, which bridges are capable of carrying E75 without any restrictions whatever (and even E90 under restricted speed), are anticipating all possible future increases in rolling loads, and at a saving of from 12 to 15 per cent of the cost of E60 bridges.

As there are practically no roads which at the present time build lighter bridges than E50, it appears that all American railways, at the present time, are profiting by past experience with short-lived railroad bridges and are fully anticipating all possible increases in rolling loads which can be operated over their tracks until their entire lines are reconstructed; and if the next quarter of a century will again record the full life of an American railway bridge it will not be because the increase in the weight of rolling stock has not been anticipated, as has been the case in the past.

FULL REGULAR SERVICE TRAFFIC CAPACITY FOR E60 BRIDGES BASED ON AN OVERLOAD OF 50 PER CENT

Locomotive	Weight	Wheel Base	Axle Load	Percentage of Increase†
Cooper's E90	405,000	23.00	90,000	50
*Atlantic	336,000	31.79	98,800	57
Prairie	427,600	34.25	99,100	75
Consolidation	411,000	26.50	90,700	58
12-wheel	413,500	27.08	87,600	58
Decapod	449,400	29.83	79,500	68
Pacific	450,000	35.20	98,000	67
Mikado	473,000	35.00	93,500	55
12-wheel articulated	523,800	30.66	87,100	56
10 coupled	515,800	43.50	86,000	43
20-wheel articulated	754,800	59.80	85,000	58
16-wheel articulated	662,500	40.17	75,400	34
24-wheel articulated	834,000	65.92	74,400	35
12-wheel electric	552,000	38.50	94,600	84
16-wheel electric	619,200	44.22	77,400	94

*The Atlantic type applies to spans under 15 ft.; for greater spans the weight of this class of engine would run over 90 per cent in excess of the heaviest type now in service.

†Percentages of increase represent the approximate increase in weight of locomotives and driving axle loads in excess of the maximum weights now in actual service.

PRESENT TENDENCIES

In regard to present tendencies, it may be stated that the introduction of new grades of structural steel and the improvements in machinery and in methods of construction are influences to be considered in future developments. There is a tendency toward the use of alloys with high ultimate strength in the long span bridges, and when these new materials inspire general confidence in their uniformity and reliability for lighter work and their production commercially becomes less expensive they may gradually replace the present standard structural steel, just as the latter has superseded wrought iron. This, in turn, may require some different types of metal bridges to be designed, so as to take advantage of the greater strength of the metal without sacrificing stiffness in the structure as a whole; or perhaps the present quality of stiffness in metal structures will give place to more elasticity.

In conclusion, it may be stated that the recent improvements in American railway bridge practice embrace the substitution of solid-ballasted decks for open decks on short-span, beam-girder bridges and for trestles; of plate girders for short-span, riveted trusses; of riveted trusses for short-span, pin-connected trusses; of stiff bracing and counters for adjustable members; and of concrete and reinforced-concrete masonry for cut stone work.

American Engineering Education Makes Rapid Advances

By GEORGE F. SWAIN

Professor of Civil Engineering, Harvard University

THIS PAPER is not a complete discussion of engineering education or of any phase of it. It only discusses the general tendency and development of engineering education in this country, and touches a few salient points.

The laboratory method of instruction, now so fully developed everywhere, was first put into operation, in any systematic way, in the United States. Even up to the time of our Civil War, or later, chemistry was studied in our colleges entirely as a lecture-room subject. Some experiments were made by the professor in the presence of the students, but the latter received no training in experimental work, except in graduate courses.

The Massachusetts Institute of Technology recognized from the beginning the importance of the laboratory method, even for undergraduates, not only in subjects like physics and chemistry, but in engineering; and, at a time when the German technical schools were offering little or no laboratory training, American schools had constructed efficient laboratories, which were used not only for research, but in which every student was required to acquire some practice in the manipulation of the apparatus and materials which formed the subject of his studies. Since that time engineering schools the world over have recognized the value of laboratories, spacious buildings have been constructed both here and abroad, equipped with the most modern apparatus and machinery for use by the students in connection with the various engineering courses.

UNFORTUNATE TENDENCIES—LECTURE SYSTEM AND OVERCROWDED CURRICULA

While the development of technical curricula and of mechanical equipment has thus been extremely rapid in this country during the last thirty years, it is a question whether methods of teaching have correspondingly improved, or whether indeed they have improved at all. A generation or two ago it was recognized that education consisted in drill, discipline and self-culture. Of late years, however, there appears to have been a tendency to consider it to consist of listening to lectures. The lecture system, the characteristic feature even now of foreign schools, has apparently steadily grown in this country, until the prevailing impression is that all that a college professor does is to lecture. The writer considers this tendency—if he is correct in conceiving that it is a tendency—to be an unfortunate one, and that much would be gained in some of our colleges and technical schools, or in some of the courses therein, in going back to the old ideas of discipline, recitation and work by the student, in place of the too prevailing practice of work mainly by the professor.

Another unfortunate tendency has accompanied the great development of engineering science and the establishment of a greater number of courses and subjects of study, and that is the endeavor to crowd a constantly increasing amount of work into the same space of time. It seems to have been too often forgotten that a four years' course, like a measure of volume, can only hold a fixed amount. In order to get into our engineering curricula, therefore, an increasing number of subjects, one or both of two alternatives become necessary, namely, either to crowd out some of the subjects previously taught, or to crowd in others at the expense of the time formerly devoted to those already existing. In other words, something had to be crowded out or the pressure had to be increased. The result has been, in the case of students who could only afford to take the standard college course of four years, a narrowing and one-sided training, or a superficial knowledge.

ARE PRESENT RESULTS EQUAL TO THOSE OF TWO GENERATIONS AGO?

Notwithstanding, therefore, the great development of our technical schools in physical resources, it may well be doubted whether the results obtained are as good as they were two generations ago, or whether we are now turning out men who are really any better qualified to develop into capable engineers than we did two generations ago. This appears to be particularly true in view of the fact that the phenomenon just discussed is not only observable in our technical schools and colleges, but in our primary and secondary educational institutions. Thoroughness, the development of initiative and the habit of reflection, seem to have been largely replaced by a smattering of many things.

The above tendencies have been accelerated and accentuated by the extension to the young and immature of the ideals of personal freedom and individual equality, so generally held up to admiration as the peculiar characteristics of a democratic form of government. The tendency certainly has been to substitute academic freedom for academic restraint and discipline. Perhaps the result has been good, on the whole, but the writer is one of those who disbelieves this.

EDUCATION A PREPARATION FOR LIFE

Education is a preparation for a vocation, perhaps, but, more than that, it is a preparation for life; and life requires not only the development of initiative, but the ability to submit to discipline, to realize responsibility to obey orders and to accomplish unpleasant tasks cheerfully and well. Education in this country to-day does not seem to be well calculated for these latter purposes; it rather trains young men to be intellectually arrogant, intolerant of others, unwilling to learn from those who have experience behind them, and to be a fit preparation for the great American game of bluff rather than for a modest, efficient and successful life.

Of course, these things, like almost all things that form the matter of subjects like education, economics, history, politics, government, etc., are incapable of exact determination. The statement can never be verified nor conclusively demonstrated that present-day education is better or worse than that of the past, because the question is not whether the graduates of our schools to-day, or any large proportion of them, achieve success, but whether the same man exposed to the same conditions would succeed better with our present education or with that of former years. Subjects of the class that we are now considering differ from those in physics and mathematical science, not only in that the conclusions reached are, in general, unverifiable, but in the fact that effects are due to a plurality of causes rather than to a single cause. These peculiarities render dogmatic statements on any of these subjects in bad taste and open to serious question.

VALUABLE SUBJECTS CROWDED OUT

Noticeable, however, is the fact that in the crowding out process, which has been referred to, some subjects have been displaced which were formerly considered among the most valuable subjects for educational discipline. Among these may be mentioned formal logic which (though included in the first course at the Rensselaer Polytechnic Institute) is now studied by an insignificant proportion of students in our colleges. Physiology, descriptive geometry, and some other subjects of great importance, have been either crowded out or greatly reduced in time.

The tendency seems to have been to replace these subjects by courses consisting too largely in the giving of mere information. Scientific facts have accumulated with such wonderful rapidity that training of the mind has been largely subordinated to the acquisition of scores of these facts. unmindful of the unquestioned truth that the ability to think correctly is a faculty which can be turned upon any subject with which the human mind may be engaged, and is, therefore the most valuable acquisition which a student can hope to make. Many will probably agree with the writer that too much is made of knowledge and too little of training.

SUBORDINATION OF THE EXCEPTIONAL TO THE AVERAGE STUDENT

Another significant fact connected with the recent development of our technical schools and colleges is the greatly increased number of students. This has led to another evil, namely, the subordination of the exceptional man to the average man. It is probably safe to say that to-day the exceptional man in our schools is held back, to a considerable extent, and made to conform to the average of the class, just as is the case in greater degree in the trades unions. There is a leveling down instead of a leveling up.

Some of our colleges have met this difficulty by offering advanced subjects in almost every field, resulting in very small classes, where men who are specially interested pursue their chosen specialties, as far as they like. This fact does not quite meet the difficulty, but rather, substitutes, in some cases at least, another one, namely, excessive specialization and corresponding narrowness. Would it not be desirable if in every subject, even those which ought to be taken by every student, the exceptional man were offered an opportunity to press ahead as fact as he could? In other words, as President Hyde of Bowdoin College has expressed it, should not our colleges run special trains for those who are capable of traveling in them?

ATTEMPTS TO REMEDY DIFFICULTIES

The difficulties which have been outlined are apparent to our educators, and an attempt is being made to remedy some of them by increasing the length of the engineering courses from four to five or six years, and by the suggestion that breadth of training may be obtained by taking a college course of three or four years and superposing upon this an engineering training, as is done in some schools of law and medicine. This fact for several reasons, does not fully meet the case.

In the first place, very few students can afford to follow the latter suggestion, and indeed a four years' course is all that the great majority of engineering students can take the time to pursue, considering the fact that when a young man has graduated from an engineering school he is by no means an engineer, but must begin at the bottom of his professional ladder in the school of experience. Perhaps this is not any more true in engineering that it is in medicine, and yet the writer believes that it is.

In the second place, engineering differs fundamentally from the law, theology, or medicine, in regard to the preparation necessary for the technical work. It matters nothing to the student of law what subjects he has studied in college. He may have studied mathematics, or the classics, or economics, or language. Provided he has a reasonably trained mind he can enter the law school and begin the study of law equally well, no matter what his collegiate training may have been. The same is true with regard to medicine and theology, though perhaps not quite to the same extent.

ENGINEERING AND APPLIED SCIENCES—PROPOSED SOLUTION FOR DIFFICULTIES

Engineering, however, resting as it does upon mathematics, the natural sciences, and mechanics, requires a definite sequence of study from the beginning of the college course. In other words; the aim should be toward applied science from the beginning, and not from the end of the college course. Does it not follow, therefore, that the best course of study for the engineer is one which is directed from the beginning toward applied science, and which includes both technical and general subjects in every year, the proportion of technical studies gradually increasing toward the end, and the proportion of general studies correspondingly decreasing?

Does it not follow also from the foregoing discussion that the difficulties which have been outlined may best be met by cutting off from the top of our present too elaborate and too widely expanded curricula, and in offering the bachelor's degree for a more general course in engineering science and the humanities, in which fundamental principles rather than practical applications are emphasized; and in attracting, if possible, men with the intellectual capacity, the money, and the time, by post-graduate courses of one or two years, leading to higher degrees, in which the various technical subjects are pursued to the limits of the various fields as they are known to-day?

The writer believes that this is the proper direction in which our engineering schools should develop, and that it will lead, if combined with improvement in some respects in present methods of teaching, to better results than have been attained within the past few years.

It may be added that it is not necessary that every engineering school should offer post-graduate courses. The great majority should confine themselves, the writer believes, to the fundamental or elementary four years' course, leaving to the comparatively few institutions who have the means, the equipment, and the men, the task of offering post-graduate instruction.

It seems to be admitted, however, that so far as concerns curricula and the opportunities for obtaining the highest engineering instruction in the various fields, there is absolutely no need to-day, except perhaps in chemistry and possibly physics, for an engineering student to go outside of the United States of America. Conditions have so changed within the past twenty-five or thirty years that while, as already stated, it was formerly necessary to go to Europe to obtain the highest instruction, it is now not only unnecessary, but it is extremely probable that better opportunities are now offered in some institutions in this country than are to be found anywhere in the world.

What Panama Canal Means to Commerce and Trade

By EMORY R. JOHNSON, Ph. D., Sc. D.
Professor of Transportation and Commerce, University of Pennsylvania; Special Commissioner on Panama Canal Traffic and Tolls, 1911-13

IN REQUESTING this paper, the chairman of the International Engineering Congress stated that:

"While the other papers to be included in this volume [upon the Panama Canal] relate wholly to technical engineering subjects, we feel that the volume as a whole would be quite incomplete without a presentation of the general subject of the economic and commercial significance of the canal, written from a broad standpoint and intended to round out for the technical reader the real significance of the canal as a development in ways and means for expediting the world's commerce."

The people of the eastern and southern parts of the United States are interested in the Panama Canal, (1) because it affords a shorter highway to the west coast of the United States, (2) because it reduces the distance to the west coast of South America and (3) because it opens a shorter route to Australasia and the Orient. The people of the western section are benefited because it gives them readier access to the markets of Europe and the eastern part of the United States, while the manufacturers and traders of Europe are benefited by securing a shorter and more direct route to the west coast of the three Americas.

TIME SAVINGS

A freight vessel operated at an average speed of 10 knots can run between New York and San Francisco by the Panama Canal in 32 days less than are required via the Straits of Magellan. It can run from Liverpool to Callao in 16 days less by way of Panama than via the Straits of Magellan. From Liverpool to Valparaiso it will save 5 or 6 days via Panama.

Before the opening of the Panama Canal the relatively large commerce between the eastern part of the United States and Australia and New Zealand was shipped via the Cape of Good Hope, the distance from New York to Australia via Suez being about the same as by way of the Cape of Good Hope. Ten-knot freight steamers can save about 16 days by using the Panama Canal for trips from New York to Sydney. From New Orleans to Sydney, the saving in time for such vessels is 22 days. A vessel sailing from Sydney for Liverpool will select the Suez route if the master of the vessel needs to discharge and take on a cargo at intermediate ports. If the vessel sails from Sydney with a full cargo for Liverpool it will probably be more economical to take the Panama route, by way of which fuel costs will be less than via Suez.

Hongkong and Manila are almost equally distant from New York via the Suez and Panama routes. It is probable, however, that most of the commerce between the eastern part of the United States and the Philippines will be handled via Panama because the trade with the Philippines will naturally be carried on by vessels engaged also in the trade with China and Japan, Manila being a terminal port for a voyage from New York to the East. Singapore is decidedly nearer New York via the Suez Canal than by way of Panama, and it is not probable that much traffic from Singapore to New York will be handled via Panama.

The trade between Europe and China, the Philippines and Japan—with the possible exception of some of the Japanese trade—will be handled by way of Suez and not through the Panama Canal. Although the entire Orient is nearer Liverpool and other European ports via Suez than via Panama, it may be economical for some of the traffic between Japan and Europe to be handled via Panama, because of lower fuel expenses, and because of the opportunity to engage in American commerce.

THE CANAL'S TRAFFIC TO DATE

The canal was opened for traffic Aug. 15, 1914, before it was fully completed. Since it was opened for traffic, slides in the Gaillard (Culebra) cut have, on a few occasions, interrupted the use of the canal for periods of one to five days, and these interruptions to traffic have doubtless somewhat delayed the establishment of regular services through the canal, and have possibly made the increase in the traffic of the waterway somewhat slower than the gain otherwise would have been. The conflict in Europe started shortly before the canal was opened, and all advance estimates as to the use that would have been made of the canal have been thrown out of line. It is probable that the war has cut in half the tonnage of the Panama Canal traffic.

The traffic through the canal, both eastbound and westbound, comprises a large number of commodities. This is especially true of the trade between the two seaboards of the United States. Among the manufactures shipped from the eastern seaboard to the west coast of the United States in large quantities in April were iron and manufactures of iron and steel, chemicals, machinery and textiles. The eastbound shipments through the canal also include many kinds of commodities, although the number of articles shipped eastbound is less than the number of those moving in the opposite direction. Sugar from the Hawaiian Islands to New York is a large single item of eastbound traffic. Lumber in relatively large tonnage is shipped through the canal to the east coast of the United States, to Canada and across the Atlantic to England. Flour from the west coast is shipped mainly to Europe.

EFFECT ON EUROPEAN MARKET ALREADY SHOWN

The lines that have formerly been operated between New York and Australia by way of the Cape of Good Hope have been changed to the Panama route. The establishment of direct steamship services between the eastern seaboard of the United States and trans-Pacific countries has already tended to lessen the importance of Europe as a market for the Australian and Oriental goods imported into the United States. The shifting of markets due to the establishment of new transportation routes is a slow process and the influence of the canal upon the relocation of the world's primary trade centers will be gradual, but, in the long run, of great importance to the United States.

The use made of the canal by American manufacturers and traders will depend upon the extent to which the steamship lines are able to compete with the rail lines for traffic originating or terminating at interior points. It is too early to reason with any degree of finality concerning the ability of the coastwise carriers to secure traffic between the Mississippi Valley and the Rocky Mountain States. There is no doubt, however, that the rail and water lines will actively compete for large west-coast shipments to and from all points between the Atlantic seaboard and places as far west as St. Paul and St. Louis.

PROBABLE EFFECT ON INLAND POINTS

Producers located at inland points will, without doubt, have to pay higher rates on goods shipped in either direction between the eastern and western sections of the United States, and producers located at or near the Atlantic and Gulf seaboards will enjoy lower rates than can be secured by producers at interior points, not only on traffic between the two seaboards of the United States, but on shipments to and from western South America, Australasia and the Orient. On account of these changes in rates at and near the seaboard, manufacturers having plants both at inland cities and at places on or near the seaboard will, probably, when it is practicable to do so, turn over to their seaboard plants orders for foreign shipment and orders requiring the shipping of goods between the two seaboards of the United States.

The advantage in freight rates which seaboard plants will have because of the canal may also be expected to result in the erection of some plants at or near the seaboard that would, if there were no canal, be constructed at inland points. The United States as a whole is so large, however, its industries are so varied and so widely distributed through the country, and the interstate commerce by rail is so many times greater than the entire traffic through the canal will ever be that the commerce by way of the canal between the two seaboards of the United States and between either of those seaboards and foreign countries can be only one of the many forces affecting the location of industries.

The first and the most direct effect of the canal is its influence upon ocean freight rates, but inasmuch as transportation rates are but one of the items in the cost of production, the indirect and most important benefit of the canal is the aid it renders in the development of industries. The general industrial effect produced by the canal through its reduction in the expense of transportation is to afford a wider market within and without the country for the products of the mills and factories of American producers. For the trade of the United States with western South America, Australia and the Orient the canal has made it possible for American industries to compete much more readily with European industries, and, as time passes, the favorable effect of these improved conditions of competition should become increasingly evident.

What should be the policy of the United States in the management of the canal?

In the long run, this will probably test the ability of the Government as fully as did the construction of the waterway. Tolls have been fixed to be paid by all vessels using the canal. The tonnage of the waterway will, it is believed, within ten years, be sufficient to enable the Government to make the canal commercially self-supporting, providing the present rate of tolls is maintained and is exacted of all vessels, American as well as foreign. Doubtless, pressure will be brought from time to time upon Congress and the President to lower the rate of tolls. The Government should resist this pressure until the revenues derived from the canal cover the annual operation and maintenance expenses and the interest on what it cost to build the waterway.

The revenues needed to make the canal commercially self-supporting will amount to about $20,250,000 per annum. This large total is made up of the following items:

Operation, maintenance, zone sanitation and government	$ 5,000,000
Annuity payable to the republic of Panama	250,000
Interest at 3 per cent upon the cost of the canal	12,000,000
Amortization of the investment, ¾ per cent per annum	3,000,000
Total	$20,250,000

By the end of the first decade of the canal's operation the tonnage of vessels using the waterway will amount to 17,000,000 net tons per annum, unless the European War should so cripple the international trade of the world as seriously to restrict for a considerable time the volume and rate of increase of the world's commerce. If the rate of tolls that has been established is maintained for ten years and if subsequent reductions in the rate of tolls are conservatively made, it will be possible for the American people to secure from the Panama Canal revenues that will recover out-of-pocket expenses and return to the United States treasury the sum that has been invested in the waterway. This can be done without restricting the usefulness of the canal, and if this policy is followed out it will be possible for the United States, with less burden to the taxpayers of the country, to construct other needed public works.

[The foregoing is a much-curtailed abstract of Professor Johnson's paper, which contains numerous tables showing the exact saving in distance and time effected by the canal, and other tables of traffic movement. It also gives an extended discussion of the transcontinental railroad rate situation, and the probable effect of the canal thereon.—EDITOR.]

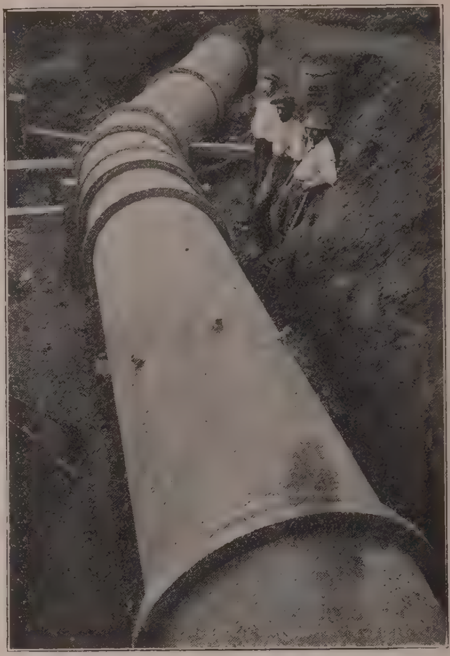
Pipe Joint Fails by Pulling Out at Elbow

Accident at Wilmington, Del., Floods Pumping Station—Repairs Involve Bracing at Curve

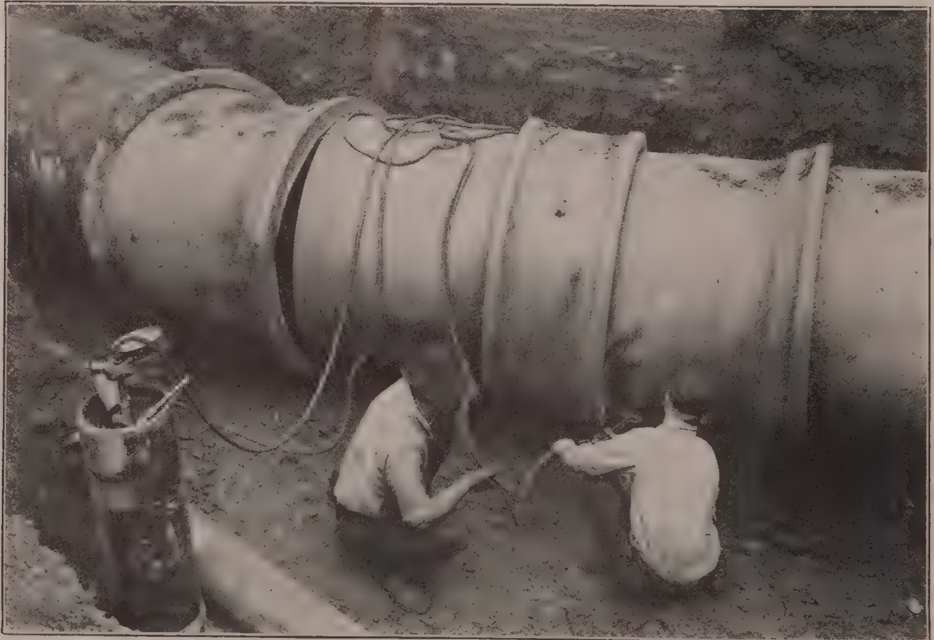
FAILURE of a joint in a 42-in. cast-iron forcing main at a point about 50 ft. from the Brandywine pumping station of the waterworks system at Wilmington, Del., was the cause of considerable damage recently. According to information received from Edgar M. Hoopes, Jr., chief engineer of the Water Department, the first evidence of trouble appeared on the afternoon of Aug. 9, when water was discovered on the pumping station lawn. The following morning the line was uncovered at the top and found to be leaking at the bell end of a 45-deg. bend. An effort was made to calk the leak under pressure, but while this work was in progress the entire joint failed, the calkers and several laborers having very narrow escapes from drowning. The check valves on the end of the line at a 35,000,000-gal. reservoir held, but the contents of the main (about 1,000,000 gal.) flooded the pumping station to a depth of about 5 ft. and completely uncovered several sections of the pipe near the broken joint.

The joint failed by pulling out at the elbow, a short piece of plain end pipe having been used between the elbow and sleeve. The main at this point was under a pressure of 115 lb. per square inch, and all joints for three lengths on either side of the elbow were pulled out at the bells from 1 to 3 in. No bracing of any kind had been placed at the elbow originally.

A repair was completed in 60 hr. of continuous work. An oxy-acetylene torch was employed for the purpose of melting out the joints to permit realignment of the main. During this period no water could be pumped to the sedimentation reservoir, and a filtered water famine was narrowly averted. The nature of the failure clearly illustrates the necessity of carefully bracing all bends to overcome the outward thrust which results from their curvature when under pressure. The bracing on the outside of the elbow shown in one of the illustrations, was incased in concrete before the trench was filled in.



REPAIRED BEND WAS BRACED AND INCASED IN CONCRETE TO PREVENT MOVEMENT



AFTER THE JOINT PULLED THE LEAD WAS BURNED OUT WITH OXY-ACETYLENE TORCHES

Canada's Railway Mileage

CANADA'S operating railway mileage totaled 30,795 on June 30, 1914, according to the annual report, recently issued, of the Dominion comptroller of railway statistics. This represents an increase of 1492 miles during the fiscal year 1914. The greatest yearly gain from 1908 to 1914, inclusive, was in 1913, when 2575 miles were added, but in none of the other years was the 1914 increase equalled. The Province showing the greatest gain was Saskatchewan, which added 438 miles and is now second, with 5089 miles. Ontario has 9255 miles. Saskatchewan passed Manitoba in 1912 and both passed Quebec in 1913.

The foregoing figures cover only the lines under operation. In addition 11,472 miles were surveyed in the whole Dominion in 1914, 5521 were under contract and 3417 were completed but not in operation. The bulk of this mileage was in the western Provinces. Alberta had 805 miles under contract and 1189 completed but not in operation, while the corresponding figures for British Columbia were 1235 and 698; for Saskatchewan, 340 and 555 and for Manitoba, 108 and 134. Ontario rivaled any single Western Province, with 1841 miles under contract and 836 completed but not in operation.

A TEST RESULT OMITTED on the diagram, page 237 of the Engineering Record of Aug. 21, may give the impression that the curve does not properly average the plotted results. One other test was included on the original diagram. It should be plotted at 21-ft. penetration just above 2 tons.

Tells Pan-American Congress How Pennsylvania Resurfaces Old Roads

William D. Uhler, Chief Engineer of State Highway Department, Advocates Use of Large Stone and Thorough Rolling

EMPHASIZING, among other details, the importance of avoiding stone of too small a size, and advocating thorough rolling, cleaning of the surface, and uniform application of bituminous material, William D. Uhler, chief engineer of the Pennsylvania Highway Department, described at the Pan-American Road Congress in Oakland, Cal., last week, the methods employed by his State in resurfacing old roads.

The essential points to be considered in the selection of a proper type of surface for an old stone road, Mr. Uhler said, are the character and amount of traffic, the grades, and, as a rule, that most important factor, the funds available for the work. When the traffic has been determined and the character of surfacing selected a thorough study should be made of the existing foundation and drainage facilities. Test holes should be made at sufficient intervals in the road to determine the depth of the existing foundation, and usually it is found that a considerable portion must be restored before a surface can be applied. Too much stress cannot be laid on the desirability of having proper lines and grades before resurfacing, in order to avoid increasing or perpetuating the difficulties of future improvement of these roads. The question of providing proper underdrainage must be considered and drains installed where necessary.

WATER-BOUND MACADAM

The methods used in the preparation of the base for both water-bound and bituminous macadam are the same. If any holes or depressions are found in the base, the road should be dug out and replaced with good-sized, clean stone, keyed with a smaller size, and rolled with a 10-ton roller until thoroughly compacted. The roadway should then be cleaned thoroughly and the existing surface broken or loosened with picks, harrows, or, if necessary, rollers equipped with spikes, so that the new material will bind properly with the old surface.

After the base course has been finished, there should be laid a layer of properly graded, approved stone, passing a 2½-in. mesh screen and being retained on a 1-in. mesh screen, this stone being known as 1½-in. stone. The stone should be spread upon the base course with shovels from piles along the side of the road or from a dumping board, but in no case should the stone be dumped upon the first course surface. This layer should be rolled with a roller weighing not less than 10 tons until it is compacted to a firm and even surface. The total thickness of the surface course should not be less than 3 or 4 in. after rolling. When a surface course of a depth of 3 in. is specified it should be laid in one layer, and a 4-in. course should be laid in two layers of 2 in. each. Should difficulty be experienced while rolling in getting the stone to compact thoroughly, sprinkling with water or spreading lightly with screenings will prove beneficial.

After the surface course of stone has been thoroughly rolled, screenings, varying in size from dust to ¾ in. should be spread, with shovels, from piles along the side of the road, or from dumping boards, but, again, in no case should the screenings be dumped directly upon the surface of the stone. These screenings should then be thoroughly rolled with a 10-ton steam roller, additional dry screenings applied, and the rolling continued without the use of water until the interstices of the stones are filled. The road should then be sprinkled with water, rolled, additional screenings spread and the sprinkling and rolling continued until the surface is well-bonded and set. The rolling in all cases should begin at the sides and work toward the center of the roadway, thoroughly covering the area with the rear wheels of the roller and should be continued until the surface is hard and smooth and shows no perceptible tracks from vehicles passing over it.

To protect a water-bound macadam road from the ravages of automobile traffic, it should be given a bituminous surface treatment of either approved tar or asphalt. Prior to applying this bituminous material the surface of the road should be cleaned thoroughly by sweeping with machine and hand brooms. After all the caked dust has been scraped off and the stone exposed uniformly over the surface, the bituminous material should be applied.

BITUMINOUS MACADAM

In resurfacing with bituminous macadam the base course should be prepared as for water-bound macadam, after which broken stone passing a 2½-in. screen and retained on a 1-in. screen should be spread on the base course. with shovels, from piles along the side of the road, or from a dumping board, to a depth of 3 in. after rolling. After the broken stone has been laid and placed true to line and grade and cross-section, it should be rolled, with a roller weighing not less than 10 tons, until the stone has been thoroughly compacted and ceases to creep in front of the roller. When the rolling has been finished there should be spread evenly over the surface a quantity of approved bituminous binder, not less than 1½ nor more than 1¾ gal. to each square yard of surface area. The binder should be heated to the proper temperature for the material used.

After the bituminous binder has been applied there should be spread a layer of ¾-in. dry, crushed, approved stone, free from dust, and in such quantity as will just cover the surface and fill the surface voids. Rolling should then be continued until the surface is thoroughly bonded; the surface then should be swept clean of all loose stone and an application of bituminous binder of approximately ½ gal. to the square yard of surface area applied evenly. This binder, in turn, should be covered immediately with a thin layer of dry stone chips, free from dust, and rolled lightly. The quantity of chips should be just sufficient to absorb the excess of bituminous material remaining on the surface and to prevent the existence on the surface of an excess of binder.

BITUMINOUS CONCRETE AND SHEET ASPHALT RESURFACING

Bituminous concrete and sheet asphalt pavements should be laid on a concrete base, instead of on the old existing macadam foundation which, heretofore, has been the generally accepted practice for country roads. In view of the increased amount and change in character of traffic, even though slightly more expensive, it is advisable to provide for either a 4-in. or a 5-in. concrete base on top of the broken stone or telford base, due to the tendency of macadam to shift or to consolidate further under traffic and possible sub-grade trouble, all of which tend to bring about a wavy or uneven condition of the surface. In conjunction with the concrete base a concrete header curb should be constructed extending 6 in. beyond the fixed edges of the bituminous pavement and to the finished grade. After the concrete base has developed a hard set, and from one to two days prior to the placing of the bituminous wearing surface, the base should be cleaned thoroughly of loose and foreign material, by sweeping, and then covered with an asphaltic cut-back mixture consisting of equal parts, by volume, of asphaltic cement, 55 to 65 penetration, and commercial naphtha, 52 to 55 gravity, the mixture being applied by a pressure distributor at the rate of ⅛ gal. to the square yard. The object of this paint coat is to secure a better bond between the concrete base and the bituminous top. The bituminous top, 2 in. in thickness, is laid under the same requirement as to preparation, laying, rolling and inspection as for a standard sheet asphalt pavement.

The following penetrations are recommended for the asphaltic cement:

PENETRATIONS RECOMMENDED FOR ASPHALTIC CEMENT

	Heavy Team or Motor Traffic, Penetration	Medium or Light Traffic, Penetration
Trinidad asphalt	45-50	50-55
Bermudez, Mexican and California	50-55	55-60

Experience has demonstrated that the turning of traffic on and off a bituminous surface will result in grinding or cracking the edges and also, unless a perfect bond has been secured with the base—and this cannot be relied upon—heavy wheel loads, at a distance of 1 to 2 ft. from the edge, will produce a spreading of the bituminous surface. To prevent this, provision should be made, no matter what the formation may be, for a 6-in. concrete header curb on either side of the road if it is not paved to the full width.

In resurfacing with a sheet asphalt top, the concrete foundation should be laid true to line and grade, and the binder and wearing surface laid to a uniform depth and raked to true cross-section and grade, after which it must be rolled thoroughly.

ROLLING IMPORTANT

Unquestionably, the most important single point in the laying of sheet asphalt wearing surfaces is the rolling. More pavements are failing to-day through displacement from original form than from all other causes combined, and aside from other reasons to which this result may be attributed —and there are undoubtedly many—it is certain that unless a pavement is free from waves at the time of its completion it never will be, as the tendency of the pavement is to push under traffic, thus increasing the wavy condition. It is important, therefore, that all pavements should be thoroughly compressed, carefully rolled and cross rolled.

In the preparation of bituminous mixtures all materials should be subjected to rigid plant and laboratory inspection.

In the resurfacing of water-bound macadam it is frequently the case that the engineer in charge of the work allows too small a stone to be used, which, it is true, will require decidedly less rolling, but will not stand the motor traffic of to-day.

Another fault quite often found is the spreading of screenings before the 1½-in. stone is thoroughly locked, and very frequently using too large quantities of screenings, thereby causing a heavy crust to form on the road surface.

The success of the bituminous treatment of water-bound macadam roads depends entirely upon the cleanliness of the road before the application of the material.

Many failures are due to the lack of proper care in this most important detail. In cleaning the surface of the road the sweeping should be windrowed along the edges of the wearing surface, in order to prevent the running off of the bituminous material, which later should be swept back on the road. Special attention should also be given to applying the chips, just sufficient chips being used to prevent the traffic from picking up the bituminous material.

In bituminous macadam or penetration work no bituminous binder should be applied unless the stone surface is thoroughly dry, and the temperature of the air is 65 deg. or higher, and special attention paid to the heating and applying of the binder. One of the important features in connection with obtaining the best results in bituminous-concrete construction is the use in the wearing surface of good, durable stone, free from dirt and decomposed material, as decomposed stone in the mixture will naturally develop weak spots in the pavement and ultimately result in failure. The penetration of the asphaltic cement used in the mixture should be governed by the character of the traffic requirements.

As before stated, the success of all bituminous-concrete and bituminous pavements is very largely dependent upon the rolling, and the best results can be obtained only by using a light roller for the initial compression and a heavier roller for the final compression, with an equal amount of transverse and longitudinal rolling.

THE COST OF ENGINEERING AND SUPERINTENDENCE in St. Louis for $1,404,316.49 worth of new construction in the water department was 3 per cent, according to the latest annual report.

Economy in Cost and Erection of Steel Building Results from Cantilever Beam Design

Mannheimer Building in St. Paul Averages Favorably in Total Weight Although Heavy Truss and Girders Were Required

SUPPLEMENTING the description in the Engineering Record of Aug. 7, page 159, of the heavy riveted truss used in the Mannheimer Building, in St. Paul, it can be stated that, in spite of the unfavorable handicap imposed by the unusual conditions requiring the use of this truss and two long girders, this building was designed with remarkable economy in total steel required. Special cantilever beam construction was adopted for the long girder-beams between columns, which resulted in a large saving in beam weights by the decrease in bending due both to the cantilever action and short suspended beams and to the decrease in the span length of the transverse intermediate beams. In addition, a saving of 8 ft. in height of building was thus effected. Important further advantages of the construction are the open vertical spaces beside the webs of the columns for pipes, sprinkler system, pneumatic tubes, etc., and the economy in erection resulting from the ease with which the beams could be slid sidewise to their seats upon the outside of the columns.

TYPICAL FLOOR LAYOUT

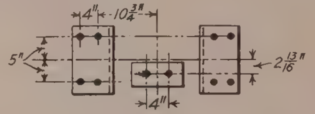
The accompanying part plan of the sixth floor of this seven-story building indicates the method adopted to reduce the steel weight. As the building is about 150 x 300 ft. in plan, a saving in the weight of floorbeams soon amounts to a large total. The scheme adopted for the long girder-beams between the columns spaced 27 ft. 3 in. apart is the use of beams offset to run past the columns in pairs and cantilever into the intermediate spans. The length of the suspended beams and the amount of overhang were fixed by trial to give equal positive and negative bending moments in the cantilever beams, and equal to the positive bending moment in the suspended beams. For the given spans of 27 ft. 3 in. the overhang for this condition was made 3 ft. 11 in.

By thus using separated pairs of beams between the columns it is seen that the floorbeams, which support a tile-arch floor construction, are shortened in span length by the distance 2 ft. 1½ in. between the girder-beams. This resulted in an average decrease of between 6 and 10 lb. in weight per foot of the floorbeams. Standard end connections were used and diaphragms consisting of a web plate and angles connect the pairs of beams.

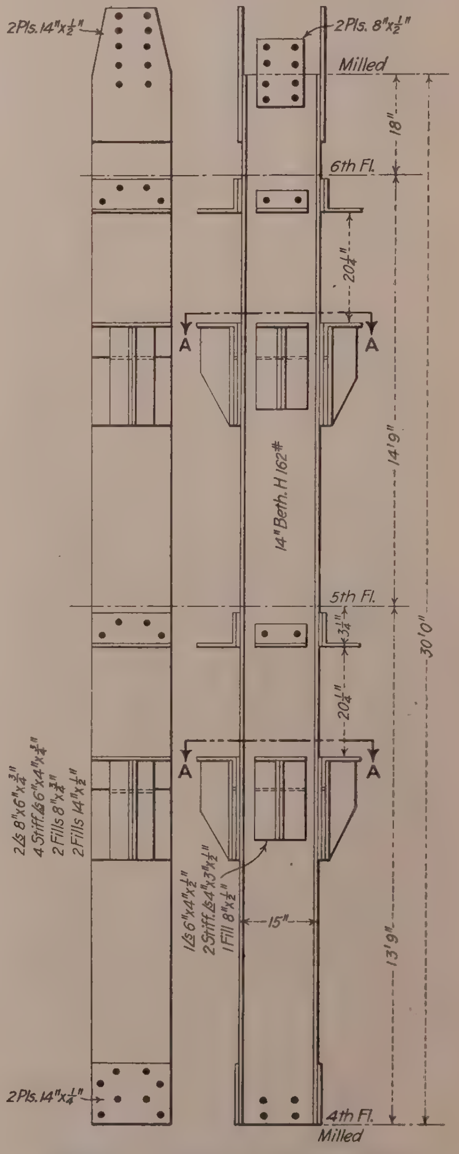
COLUMN AND BEAM DETAILS

The typical connections and column seats are shown in one of the drawings. It is worthy of note that the connections are symmetrical and the loading is practically so when the action of the connecting diaphragms between the pairs of beams is considered.

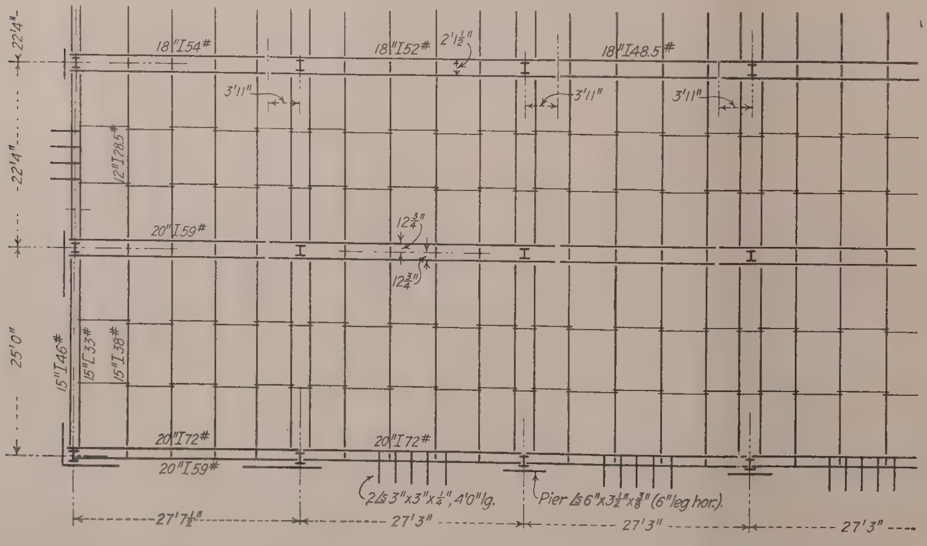
It is further evident that the connection between suspended beams and cantilever beams, shown on the detail, is quite stiff.



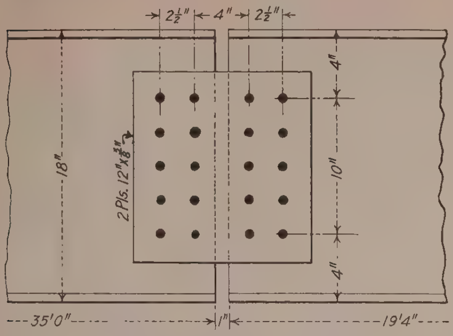
Connections at A-A



DETAILS OF COLUMN CONNECTIONS



PART PLAN OF SIXTH FLOOR SHOWS CANTILEVER BEAM LAYOUT



CONNECTION BETWEEN CANTILEVER AND SUSPENDED BEAMS

The assumption of simple beam action is therefore not exact, but of course errs on the side of safety as in the case of all beams having rigid end connections.

RELATIVE ECONOMY

The use of pairs of I-beams between the columns instead of single girders resulted in a decrease of about 8 ft. in the total height of the building, due to the decreased depth and the fact that fixed beam clearances were specified. Cantilevering the floorbeams over the girder-beams was also considered, but was not adopted because it would have resulted in the loss of the economy due to the decreased height just mentioned.

The total weight of steel in the building, including the column bases of cast iron, is nearly 4300 tons. This gives an average of 1 2/3 lb. per cubic foot for the 5,000,000 cu. ft. above sidewalk level. Figures furnished by the architect show that twelve similar New York and Chicago buildings averaged 2 2/3 lb. per cubic foot, and none ran below 2 lb. The difference of 1 lb. per cubic foot amounts to 2500 tons for this building. The relative economy of the cantilever type of floor is therefore quite evident, although part of the low weight may be due to the lighter Bethlehem sections, which were used throughout for columns and beams. To offset, this, however, the columns were designed for the loading due to a possible future addition of one story in height.

The building was built for the Mannheimer Realty Company, of St. Paul; A. H. Stem of that city was the architect, O. S. Payzant, of New York City, was the designing engineer, and the steel was fabricated by the Minneapolis Steel & Machinery Company, of Minneapolis.

Build Standard-Gage Railroad to Haul Road Materials

Low Cost per Ton-Mile Obtained at New Lexington, Ohio, by Bringing Freight Cars Directly to the Job

ALL MATERIALS, consisting of 1000 carloads of screened gravel, sand, cement and brick for 6.1 miles of 16-ft. brick road, with a concrete foundation, now under construction at New Lexington, Ohio, are being hauled directly to the job in railroad cars without rehandling. A 65-ton geared steam locomotive is used to pull the cars over a spur built entirely upon new right-of-way. The track, which is standard gage, is constructed with 60-lb. relay rails. Sixty per cent of the ties are railroad unspiked discards and are used only to furnish bearing. The remainder are standard ties which hold the gage.

Some trouble was anticipated, due to the possibility of the track settling on new fills. As a result the ties on the fills were spaced closer and 3 or 4-in. saplings were placed under the ties parallel with the rails. However, the fills are few and all are short. The track is laid just outside the limits and parallel with the curb of the new road. A number of 4, 5 and 6 per cent grades are encountered.

OPERATION OF MATERIAL TRAIN

For the concrete work a train consisting of one car of screened gravel, one car of sand and one of cement is kept moving alongside the Koehring paving mixer. The original intention was to use a tank car for hauling water for the concrete work, but owing to the heavy grades it was decided to pipe the water and thereby relieve the work of the locomotive.

The gravel car is spotted directly opposite the mixer. A batch hopper is hung on the side of the car and is loaded while the mixer skip is discharging into the machine. When the skip is lowered to the ground a gate in the batch hopper is opened and gravel is shot into the skip. The sand car is pushed ahead of the gravel car, and sand is unloaded through a chute into wheelbarrows. The cement is unloaded from the cement car and distributed along the line of the work. One man is kept busy dumping cement into the skip.

TOTAL AND TON-MILE HAULING COSTS

First cost		
New hardwood ties, 4000 at 32 cents	$1,280	
Old ties from railroad, 12,000 at 10 cents	1,200	
Relay rail, 60-lb., 550 tons at $17	9,350	
Labor laying and removing track, 32,000 ft. at 15 cents	4,800	
Locomotive	4,500	
		$21,130
Operation, 8 months at $250		2,000
		$23,130
Salvage		
Scrap rail, 550 tons at $13	$7,150	
Locomotive	1,500	
		8,650
Net cost		$14,480

1000 cars, or 40,000 tons hauled an average of 3 miles equals 120,000 ton-miles. Cost per ton-mile, 12 cents.

THIS METHOD OF HAUL COST THE CONTRACTOR 12 CENTS PER TON-MILE

The cars of brick are unloaded by carriers and laid directly from the car. The accompanying photograph clearly portrays the concrete train at work on the job. High speeds are not needed and considerably fewer trips were necessary than with other common methods of transportation.

The foregoing table indicates a haulage cost of 12 cents per ton-mile. The contractors are Swank & McIntyre of Dayton.

Rochester Effects Saving by Using Odd-Diameter Pipe

Although There Were Doubts as to Character of Interior Surface Due to Wrapping Cores, Lengths Were of Excellent Quality

THIRTY-SEVEN-INCH PIPE, instead of the standard 36 in., was used last year by the city of Rochester, N. Y., in laying 7.69 miles of a new 25-mile conduit from Hemlock Lake, the city's source of water supply, to the city. As a result there was a large saving in tonnage and a considerable increase in carrying capacity. The outside diameter of a standard 36-in. pipe was adhered to, thus allowing the use of standard curves and other specials. The pipe selected as a basis was the standard "Class D" section of the American Waterworks Association, which has an outside diameter of 39.16 in., or a wall thickness of 1.58 in. Using this outside diameter, and a wall thickness of 1.04 in., the inside diameter was 37.08 in., or roughly 37 in.

When bids were called for the manufacturers demurred, contending that the wrapping of the standard 36-in. cores to secure the larger diameter might result in pipe with rough inside surfaces. The city engineer's office reports, however, that the pipes delivered were among the smoothest ever received. The standard flasks, of course could be used without alteration.

It is proposed to complete the line as soon as funds are allotted for the work. It is expected that tenders will be invited on both steel and cast-iron. For the latter still other diameters than the 37.08 in. will be called for, the increase in head in the lower reaches demanding greater wall thickness. The sizes to be used and the quantities of each to complete the line to Rush Reservoir, 9.68 miles, are as shown in the table on page 394.

The argument against the use of special

SIZES AND QUANTITIES OF PIPE TO BE USED, WITH RESULTANT SAVING

Rochester class	Approximate Length, Ft.	Wall Thickness, In.	Inside Diameter, In.	Max. Allowable Head, Ft.	Wt. Per Ft., Lb.			Total Saving, Tons
					Standard	Special	Saving	
A.	11,130	1.04	37.08	137	625	425	200	1130.0
B.	14,600	1.20	36.76	225	625	487	138	1007.4
C.	24,000	1.42	36.32	329	625	570	55	660.0
D.	......	1.58	36.00	...	625	*..	...	......
Total saving								2797.4

Class D fittings used throughout.
*Standard.

sizes does not apply in this case, since the quantity required is sufficient to justify the necessary changes by the manufacturer while the large tonnage could not be taken from stock, but had to be cast on order.

The pipe for the first section was furnished by the United States Cast Iron Pipe & Foundry Company of Philadelphia, and inspected at the foundry by William R. Conard. The pipe dimensions were fixed by the city engineer's office at Rochester. Alternate proposals were received on 37-in. lock bar and welded pipe and 39-in. riveted steel pipe ¼ in. thick. The cost of hauling and laying and the relative permanency of the different materials were elements entering into the final selection.

Chicago Should No Longer Depend on Sewage Dilution

Experts Deem Filtration Necessary—River and Channels Denominated Open Sewers Violating First Law of Public Health Work

THAT the present means of protecting the water and getting rid of the sewage in Chicago are not, and cannot be, made satisfactory and that decided changes are needed both as to policy and procedure is the final opinion expressed by a board of three international sanitary engineers on Chicago's sanitary problem in their final report to the Real Estate Board. The board consisted of George A. Soper, New York, Arthur J. Martin, London, and John D. Watson, Birmingham, and spent 13 months in studying the extensive literature on the subject, following a fortnight of attention to the problem on the ground. A preliminary report submitted on May 1, 1914, was abstracted in the Engineering Record, page 578, May 23, 1914. The following conclusions are taken from the final 212-page cloth-bound report just issued by the Chicago Real Estate Board. Most of the statements contained in the preliminary report are confirmed in the final draft.

However perfect the dilution scheme may once have appeared from a theoretical standpoint, in practice it has proved to be inadequate both as a means of obtaining pure water and as a means of getting rid of the sewage. It has never produced completely satisfactory conditions at Chicago and it never can do so. It has produced insanitary conditions for many miles down the drainage channel and the Desplaines and Illinois Rivers.

WATER SUPPLY NOT SAFE

The idea of excluding all the sewage from the lake calls for the placing of a larger territory under central sanitary control than is practicable. The region whose drainage pollutes the lake lies in four States. There is occasional contamination to be feared from vessels in spite of any precautions which can be taken. In short, the sources of pollution which now exist are too numerous, too various and under too many governmental jurisdictions to be centralized.

The vital statistics can be quoted either to show that the water supply is, or is not, dangerous to health. In comparison with some cities, the typhoid rate is high, with others low. The water supply is, and long has been, occasionally polluted, according to detailed official analyses which have been examined by the board of experts. The United States Public Health Service classes Chicago with cities whose water supplies are subject to intermittent pollution with great dilution of the polluting material. In the opinion of Dr. Young, former head of the Chicago Health Department, waterborne typhoid cannot be considered as having been entirely eliminated. It is the opinion of the board of experts that the water supply is not safe.

RIVER AND CHANNELS OPEN SEWERS

Chicago's policy of using its river, and constructing canals, some of them running through the business and residence sections of the city, as open sewers, is not in accordance with good sanitary practice and should be given up. Limits of pollution should be established for these waterways based on what is proper under the conditions, and the necessary works should be built.

For cities to utilize the self-purifying capacity of water for the ultimate disposal of their sewage is quite justified under proper circumstances, but to cast the entire burden of Chicago's filth upon the Chicago River and its artificial outlet is to impose conditions upon these waterways which are alike insanitary, unfair and unnecessary. It violates the first law of public health work, which is that dangerous and offensive wastes shall be promptly removed from their points of origin and kept under control until they are rendered harmless and inert.

Aside from Chicago's right to appropriate the largest river in the State for the purposes of sewage disposal, a proceeding the justice of which is here questioned, the result in the city of Chicago is not satisfactory. The scheme as it exists to-day, after 15 yr. have been devoted to its perfection, leaves very much to be desired. There is not an arm or branch of the Chicago River which looks clean when viewed in the light of what has been accomplished in cities where sanitary problems have been adequately dealt with.

SEWAGE WORKS PROPOSED

A policy of prevention rather than cure is recommended in attempting to keep the Chicago River clean. Instead of discharging sewage into the river in unlimited quantities and without restriction as to composition, limits should be placed upon the quantity and amount of domestic sewage and trade wastes which it may receive. Restriction should be placed not only upon industrial drainage, but upon domestic sewage as well. Only that part of the drainage which the water can absorb can carry away without producing offensive conditions anywhere should be emptied into the waterways. The remainder should be collected and disposed of in such ways as the experience of Chicago and other cities shows to be desirable and the opportunities of the situation permit. Intercepting sewers, screens and settling basins will have to be employed extensively and it is probable that more efficient methods of purification will be required to a considerable extent. It is recommended that trade wastes should be dealt with at private expense when, by reason of their volume, nature or strength, they add unduly to the cost of treating the sewage.

WATER FILTRATION

No plan or method of dealing with the sewage will afford the complete protection of the water supply which is desirable, and the city must face the fact that the water supply should be purified. Filtration works can, and should, be constructed at once for a part of the water supply and extended later to cover the entire supply as necessity and opportunity present.

The adoption of a policy of cleaner waterways and a cleaner water supply does not run counter to the plan, which the city has followed, of diverting all the sewage from the lake and keeping the lake water as pure as possible for drainage purposes. The filtration works are necessary to supplement the sewage works and are required for the reason that the sanitary and ship canal alone is not capable of accomplishing the results required. It will always be desirable to keep as much sewage as practicable out of the lake and to dispose of the sewage with as little offense as is consistent with a due regard to economy.

It may be expected that the standards by which the success of the sewage disposal works and water purification plants is to be tested in the future will be considerably in advance of those of to-day. In the recommendations here made that the water and sewage be treated, due allowance is made for the development of the works as an ultimate to secure a higher efficiency than is at first needed.

PROGRESSION PLAN

The works here recommended can and should be built in accordance with a progressive plan. It is not intended that the whole, or any very large part of the structures which may be needed 50 yr. from now shall be put into the ground at once. But the outlook should be sufficiently broad and the plan sufficiently comprehensive so that whatever building is done shall be toward a result which is clearly foreseen.

The next step which should be taken toward a sanitary disposal of Chicago's sewage is the preparation of a definite general plan and policy of sewage disposal which will show what works are required, where they should be located, when they should be built, and what they should cost. To do this work properly will require an intimate knowledge of the ground.

THE PRODUCTION OF PETROLEUM in the United States in 1914 aggregated 290,312,535 bbl., states a bulletin issued by the U. S. Geological Survey. Of this 265,762,535 bbl. were either marketed or utilized directly in field development, and 24,550,000 bbl. were placed in producers' storage. The amount marketed or utilized in 1913 was 248,446,230. As the average price per barrel in 1914 was only 80.6 cents, however, as compared with 95.4 cents in 1913, the value of the marketed production was only $214,125,215 in 1914, as against $237,121,388.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Large Quick-Dumping Concrete Car Used at 46th Street Pier

THE CONCRETE car shown in the accompanying photograph discharges a batch into the hopper at the top of the cofferdam, from which the concrete is spouted to place, makes a trip to the mixing plant 100 ft. away and returns with a fresh batch before the first one has run out of the hopper. It is handled by a dinky, and carries a crew of two men, one to open the lever gate, and one on top to load the car. The car holds 2 cu. yd. and is lined with sheet steel.

This car is in use for spouting such parts of the pier footings within the cofferdam as can be reached by chute from the top of the cofferdam. Much of the first concrete, now being placed, is handled by locomotive cranes in dump buckets, and a great deal of concrete will be chuted later on in the construction. It was not feasible to put up a tower at this stage, as it was not practicable to locate the concrete plant on the center-line of the pier. The piles for the new pier are largely driven, which has necessitated setting up the concrete plant on the cofferdam over the new north slip, so that its derrick can reach the material barges.

This contract is being carried out by the Holbrook, Cabot & Rollins Corporation under the direction of Thomas B. Bryson, with Daniel Hughes as superintendent.

CAR, HOPPER AND MIXING PLANT AT NEW YORK PIER

CAR DISCHARGES IN FEW SECONDS

2000-Ton 14-Story Building Underpinned without Settling

TWO THOUSAND tons of brick, steel, and wood underpinned without accident, damage, or settling more than 1/16 in. is the feat accomplished recently in shoring the front end of the Adams Express Company Building, Chicago. This work was done in connection with the enlarging of the basement and bank floors of the building. About 2500 24-in. jacks, capable of lifting 5 tons each, were used.

The front piers of the building were cut out and replaced by 20-in. needle-beams. A side of a pier was cut out at a time and small pump-locks and screws placed until the entire pier rested directly on the jacks and drums. Then the jacks were removed one row at a time and the needle-beams inserted. In order to take the load off the piers the contractor shored under the ends of the beams with five rows of drums and screws. The piers were then removed and the structural steel set in place.

Level readings were taken on the piers three times a day to keep track of any tendency to settlement. In order to maintain the building at the original level, men were kept constantly turning the screws. The blocking settled 8 in. but the piers have never been below their original level.

LARGE NUMBER OF SCREW JACKS USED

Crowe Brothers, of Chicago, were the shoring engineers.

Large Drill Boats Used at Halifax Ocean Terminals

TWO DRILL boats used in submarine excavation for the Ocean Terminals at Halifax, N. S., drill their holes through 6-in. casing pipes, which are pulled by clamping them to the boat and raising the scow on its spuds. The charges of dynamite are made up in cartridges and lowered to the bottom of the holes with the wires attached to small floats, which support them at the top of the water while the casings are being withdrawn. When these casings are clamped to the scow at the level of the deck, the spuds are shoved down, raising the boat and the casings with it until the latter are free and can be withdrawn. The boat is then removed some distance, the lead wires carried on the floats are connected up, and the blast is fired with a battery. Dynamite is carried on a special scow, which is shown in front of one of the drill boats in the accompanying photograph. This drill boat carries a battery of seven drills, while the other is equipped with a battery of ten.

DRILL BOAT AND DYNAMITE SCOW AT HALIFAX TERMINAL

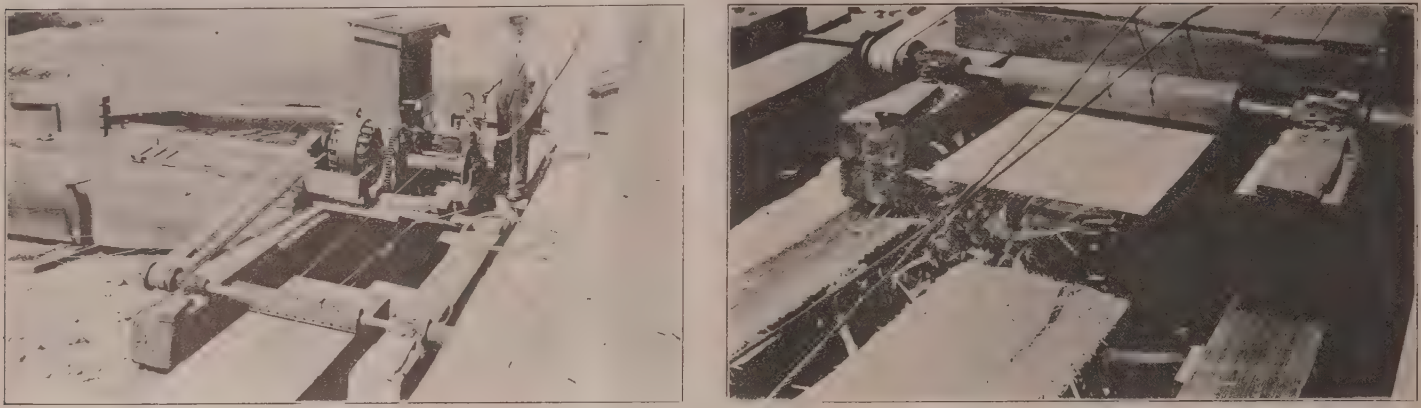
Work on the Halifax Ocean Terminals is being carried on by Foley Brothers, Welch, Stewart & Farquier, with L. G. Fuller as general superintendent.

Home-made Planer Used to Size Large Timbers on the Job

By R. W. CADY

Assistant Engineer, Cayuga & Seneca Canal

THE HOME-MADE planer shown in the accompanying photograph was used to size accurately on the job the large timbers employed in constructing wooden lock gates for barge canal locks on the Cayuga and Seneca Canal. These timbers varied in size from 24 x 34 in. x 27 ft. to 12 x 24 in. x 27 ft. Each leaf of these gates is built by placing timbers on top of each other, the largest at the bottom grading up to the narrow ones on top. In order to have these sticks fit closely together and build up plumb, it was necessary that the top and bottom of each should be perfectly flat and parallel. At the mill in the West where the timber was bought it was impossible to dress timbers larger than 30 in. wide. Even the smaller timbers that had been surfaced at the mill were so much "in wind" by the time they reached the site that they had to be redressed before they could be used.



HOME-MADE PLANER THAT SURFACES BIG TIMBERS ACCURATELY ON THE JOB, AND ITS CUTTER HEAD IN ACTION

This tool is mounted on a movable platform about 16 ft. long under each side of which is a 12 x 12-in. timber. Each timber is fitted with hardwood blocks to reduce the sliding friction. These blocks slide in a track on two 12 x 24-in. x 46 ft. timbers, which are set on edge about 4 ft. apart. The tops of these timbers were set perfectly level in the same plane and made very smooth. An air hoist mounted on the platform hauls it back and forth on the long timbers by cables running to deadmen at each end. A 38-in. cutter head driven by a 10-hp. motor is mounted on one end of this platform so that its axis is perpendicular to the axis of the timber track and parallel to the plane in which the top of this track lies. Between the two 46-ft. sticks, or ways, are placed two bolsters which can be adjusted by screw jacks set under each end.

The timber to be dressed is placed on the bolsters between the ways and the screw jacks are adjusted till the top of the timber is in the right position for making the first cut. The motor is then started driving the cutter head, and the platform is dragged over the stick by the air hoist. About ¼ in. is the maximum cut that can be made in one operation. As some of the timbers are an inch or more out, it requires four or five cuts to surface them. The capacity of the machine is seven or eight sticks a day. It requires two men to operate it and the service of a crane to handle the timbers.

The results were so good that when the timbers were erected in the gates, which are 41 ft. high, there were no cracks that would leak and the gates measured the same at all points. The machine was devised and built by the Drilling & Contracting Company of Albany, N. Y.

Platform Raised with Tackle Used to Erect Subway Roof Forms

INSTEAD of building a car to the full height of the subway section to handle steel forms for the jack arches of the roof, the contractor for the 138th Street-Southern Boulevard section of the east branch of the Bronx subway in New York City is using a light platform hung from the steelwork with four sets of falls. This platform is pulled up under the roof, the forms are taken down and landed on it, and the whole is lowered by the falls and landed on a small car running on the construction track below. The car is rolled forward, the falls are hooked to the steel or to slings previously hung, and the platform is raised in position to set the forms in the next section.

The small cars can be used for many other purposes, and are run on the regular track without being in the way as a full height carriage would be, unless an outside track were provided for it. The entire arrangement is light and easily handled.

Work on this section is in charge of H. R. Shailer, superintendent for the Richard Carvel Company, Inc. R. S. S. Guerber is section engineer for the Public Service Commission.

Light Cableway Outfit Handles Heavy Dragline Bucket

IN ORDER to avoid deep borrow pits, which result in excessive seepage, in connection with levee work on the Mississippi River below Memphis, a drainage contractor designed and constructed the cableway dragline apparatus shown in the accompanying photograph. A light-weight tower which could be moved quickly and easily over the wet, soft ground was obtained by dragging the heavily loaded 6-yd. bucket along the ground, thus taking the strain off the towers.

The tail tower is anchored by means of a movable counterweight which consists of a large wooden box filled with sand. When the tower is to be moved the weight, which hangs from a boom, is swung forward to its new location. It is then detached and the tower run ahead on its track the required distance. The maximum distance between towers is 500 ft. About 1000 cu. yd. of earth are handled in a 10-hr. day. According to R. H. & A. G. McWilliams, the contractors, of Chicago and Memphis, by taking the strain off the towers they have greatly increased the life of the cableway and minimized cable repairs.

PORTABLE DRAGLINE TOWER MOVES ITS OWN DEADMAN

LIGHT CABLEWAY DOES NOT RAISE BUCKET FROM GROUND

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Collapse of Street Decking Follows Subway Blast

As Timbering Falls Crowded Seventh Avenue Street Car Plunges to Bottom of 28-Foot Cut for New York's New Rapid Transit System—7 Killed

A blast of the usual size, fired at 7.56 a. m., Sept. 22 in the east half of the main cut for the new Seventh Avenue subway just south of Twenty-fifth Street in New York City, was followed by the collapse of the street decking for the full width of the roadway south to a point below Twenty-fourth Street, where the street load had been transferred to the last permanent steel erected. This section of the subway is being built with unusual steel support for the timber street decking, which has been criticised by construction men for its unnecessary weight and strength. The method of support gives a clear, full-height working face, and, because the section is in rock cut, requires a minimum of horizontal bracing below the level of the steel beams. It was described on page 57 of the Engineering Record of July 10, 1915.

Condition at Time of Shot

At the time of the shot the needle-beams on the east side of the street, where the shot was fired, were carrying the decking for a span of some 30 ft. Those on the west side of the street, where the excavation was not quite so far advanced, were probably not carrying the entire load, as the cross-beams had been posted down to the floor of the shallow heading cut preparatory to advancing the needle-beams. The hangers securing the cross-beams to the needle-beams were, however, still in place. After the collapse these beams and the section of decking they supported remained intact, while the south end of the east pair, and the decking over them, fell to the floor of the cut.

Condition After Collapse

The decking over the shallow heading above Twenty-fifth Street did not collapse; neither did the sidewalks, except for half their width at a few points. These sidewalks had, for the most part, not been decked, and were sup-

(*Continued on page* 400, *first column*)

World's Engineering Works Reviewed by International Congress at San Francisco

General Goethals Tells of Panama Canal at Opening Session—Materials of Engineering Discussed—Record Tunneling at Rogers Pass Excites Interest—Activated Sludge the Chief Topic at Sanitary Session

(*By Telegram from San Francisco*)

Interest in the administration and technical features of the Panama Canal and in the development of the Diesel engine were the chief features of the sessions of the International Engineering Congress held prior to the recess on Wednesday afternoon, Sept. 22. The session devoted to these subjects drew the largest attendance. Discussion in all of the sessions, however, was disappointing, due to the limited advance distribution of papers. Furthermore, the authors, in most cases, were absent, a fact tending to suppress the questions which might ordinarily be put. The papers, however, possessed unusual value and, collected in volume form, will make most valuable contributions to the literature of engineering. No attempt will be made here to summarize the papers.

Those papers that are of importance to the readers of the Engineering Record will be printed in part or in abstract in early issues. Extracts from eight of the papers appear elsewhere in this issue.

Goethals Speaks of Canal

The first session Monday morning was an impressive gathering, fully befitting the magnitude of the work, the Panama Canal, which occasioned the Congress. On the platform with the honorary president of the Congress, Major-General George W. Goethals, were the vice-presidents, the foreign delegates and the presidents and secretaries of the national engineering societies. The keynote speech emphasizing the purpose and the occasion of the Congress was made by Dr. William F. Durand, chairman of the committee of management. General Goethals spoke next; he sketched the historic settling of the Canal, the efforts made and the plans projected since Spanish times for connecting the two oceans. He emphasized too that the Canal, calling into play almost every branch of engineering, might well be the inspiration for the gathering of specialists of every class, while the world-wide influence of the Canal on commerce justified its selection as the prime motive for an inter-

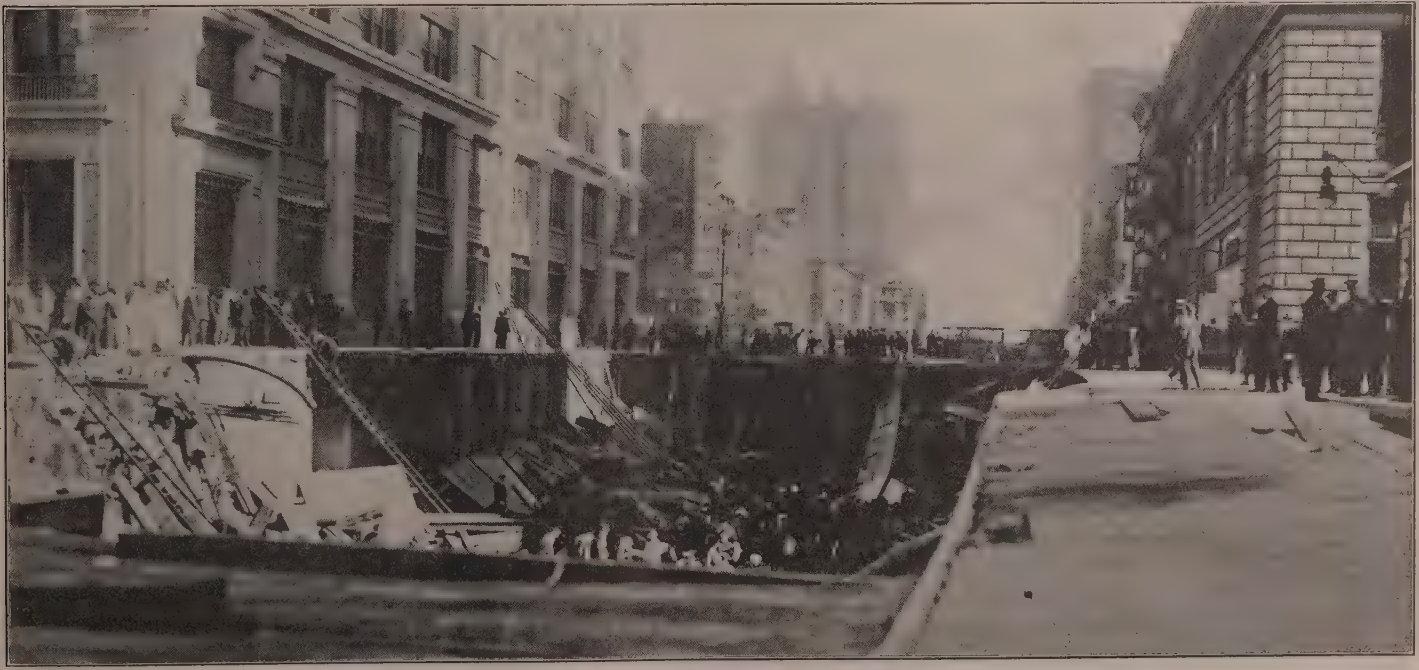
New Committee Will Harmonize Good Roads Movement

Body Appointed at Pan-American Road Congress to Secure Co-operation Among All Highway Organizations—Military Road Approved

(*By Telegram from San Francisco*)

One effect of the joint meeting of highway associations at the Pan-American Road Congress, in Oakland, Cal., last week may be a single national meeting in the future, instead of separate meetings of the leading organizations, as in the past. This, at least, is the inference drawn from the American Highway Association's action in appointing a committee to confer with representatives of other organizations to "harmonize" the good roads movement. The resolution is given in full below. The Congress went on record in favor of a Pacific Coast highway as a measure of military preparedness. The following report of the sessions is a continuation of the one published in the News of the Week section last week:

(*Continued on page* 402, *first column*)



A BLOCK OF DECKING COLLAPSED, KILLING SEVEN IN NEW YORK SUBWAY CONSTRUCTION ACCIDENT national gathering. General Goethals took advantage of his survey of the Canal's history to pay graceful tribute to the achievements of his predecessors and the loyal support and invaluable assistance of his confreres in the work. To John F. Stevens and John F. Wallace he paid special tribute, outlining in some detail the particularly important accomplishments of their administration.

Tribute from Foreign Delegates

Following his address General Goethals greeted the officially accredited delegates from foreign countries, each responding with a few words of felicitations. One could not but be impressed by the sincerity of the delegates, their admiration of the success of American engineering genius and their appreciation of the honor conferred in inviting their countries to be represented at the gathering. It is not too much to say that the presence of these delegates and their addresses gave the gathering a singular flavor that emphasized strongly the momentous character of the Congress. The enthusiasm of the French delegate, Jean De Pulligny, and the polished and gracious response of the Swiss delegate, Prof. A. E. Rohn, were especially noteworthy. Besides these two delegates the representatives of Canada, Cuba, China, Guatemala, Japan, Netherlands, Nicaragua, Spain and Sweden presented their felicitations.

The program called for the presentation to Dr. James Douglass of the John Fritz Medal, a feature that had to be omitted owing to the absence of Dr. Douglass who was detained in the East by illness.

The real business of the convention began Monday afternoon with a well attended session on the Panama Canal. The papers were general rather than engineering, taking up organization, administration, purchase of supplies, geology and the commercial and trade aspects of the Canal. One engineering paper on the climatology and hydrology of the Canal was presented at this session. All of the papers dealt with matters treated in this journal to a greater or less extent, depending on the particular subject, during the past seven years. There was only one discussion by C. E. Grunsky. He advocated that the Panama Canal, like river and harbor improvements, should not be expected to pay back into the treasury of the United States its cost, or, in other words, that amortization charges should not be included in the operating expenses. He believed it permissible, however, to provide in the tolls for interest at a low rate upon the cost.

Technical details regarding the Canal were treated in ten papers presented in two succeeding sessions, both well attended. While there was no discussion, numerous questions were put to General Goethals, General Sibert and Mr. Williamson, the principal Panama Canal engineers present.

Engineering Materials Discussed

Tuesday morning the Congress split into sections with six to eight sessions in progress simultaneously. At the first session, on materials of engineering, timber was taken up. The principal papers were valuable contributions by H. S. Betts and W. B. Greeley of the Forest Service on structural timber in the United States and by Howard F. Weiss and Clyde H. Teesdale of the same service on preservative treatment of timber. The discussion was meager. E. J. Mehren of New York described the unsatisfactory condition of the timber market in the eastern part of the United States which had forced the abandonment of specification by botanical species and the adoption of the density or ring clauses. Prof. Charles B. Wing of Leland Stanford University pointed out that a similar condition did not occur on the Pacific Coast, the differences in the structural timbers being so great as to be readily distinguished by the eye. Other papers described the timber resources of Canada, India and Russia.

The second session on materials, devoted to concrete, brought out no discussion. At the third session there were excellent papers on the outlook for iron by Prof. James F. Kemp of New York and on alloy steels in bridge work by Dr. J. A. L. Waddell of Kansas City. Professor Kemp reviewed at length the iron resources of the world and particularly of the United States, concluding that supplies for the next 200 or 300 years are in sight, even under large increase in use.

Railway Location

The second session on railways, following the presentation of the paper on locating a new line, by William Hood, chief engineer of the Southern Pacific, brought out a discussion on the extent to which practice for locating steam lines could be modified for a line to be operated electrically. It was advanced that the shorter wheelbase of the electric locomotive allowed the use of sharper curves while its great overload capacity for shorter periods permitted steeper short grades than does the steam locomotive. Mr. Hood, however, was of the opinion that it is not advisable to locate a line on the theory that steam equipment will never be used on it. Such an assumption is not likely to be borne out. Consequently he did not favor modification of steam-line locating practice for sections to be electrified.

Tunneling at Rogers Pass

Following the presentation, by Charles S. Churchill of the Norfolk & Western Railway, of his paper on "Tunnels," J. G. Sullivan, chief engineer of the Canadian Pacific, emphasized the reasons for using the pioneer drift in driving the 5-mile Rogers Pass tunnel. With this scheme it has been possible to keep men at work drilling, mucking and loading except where shooting is actually in progress. As a result the contractors have broken the American record in tunnel driving. Whereas the original offers of contractors for driving the tunnel called for completion in seven years, the bore will actually be finished in three and one-half years, half of this time being taken in the approaches. He emphasized that the scheme was applicable only in hard rock.

Commenting also on Mr. Churchill's paper Mr. Hood remarked that he could build a tunnel 17 ft. wide almost as cheaply as a 14 or 15-ft. tunnel. The added width resulting in convenience and safety to track men who need not run to places of refuge is well worth the slightly greater cost.

Sewage Treatment

In the discussion on sewage treatment George W. Fuller, of New York, commented on the activated sludge plan as sound in theory and very promising, in that clarified liquid and non-putrescible sludge is produced. On the other hand questions of power and attendance might make it uneconomical. He emphasized the need for experienced management of sewage treatment plants as absolutely essential to satisfactory operation. In sewer construction the engineer should make provision, he thought, for proper inspection of house connections to insure tight pipe joints. He cited the case of a large sewer construction job in which 2 per cent of the total cost was allotted to rigid inspection of joints in the mains, but later on, when the house connections were made, there was no adequate joint inspection and the resultant storm-water leakage into the laterals flooded the sewage treatment plant.

Mr. Fuller said he had abandoned mortar joints and has substituted bituminous compounds to secure tighter sewers. Captain K. Hallen, of Sweden, cited the favorable experience in that country with Imhoff tanks about 30 ft. deep, built with enlarged top cross-sections to lessen scum troubles. Mechanical agitation was highly desirable, he thought. Charles Gilman Hyde estimated that there were about forty sewage farms in California, but that, as a rule, they were not highly successful. He suggested that further study of this question, particularly in the dry Southwestern States, would be well worth while. Edward Bartow expressed an opinion that fine screens remove very little of the putrescible matter unless the sewage is fresh.

In the discussion on water supply papers the question of how to increase metered water consumption was raised. A California town has a contract with a water company for a fixed minimum quantity greater than the present consumption and is endeavoring to encourage consumers to use more water. John R. Freeman suggested that sliding meter rates in use in other localities have produced good results and seem fair to company and consumer.

West's Scenic Splendors Enliven Trip to International Congress

The "Engineers' Special," carrying delegates from New York and other Eastern cities to the International Engineering Congress, reached San Francisco on time at 9 p. m., Sept. 15. The long journey across the continent was interrupted at Colorado Springs, where a day's stop had been arranged for a trip to Pike's Peak on Sunday morning, Sept. 12. The engineers went by automobile to Crystal Park over a remarkably tortuous and steep highway cut into the sides of the mountains. In the afternoon various parties were organized, the largest group, which numbered about seventy, electing to go up Pike's Peak. About twelve took the regular train on the cog railway at 1.30 p. m., the other two left in special cars at 2.30 p. m. The first of the latter was brought to grief within 15 min. after starting by the breaking of one of the pistons of the engine, necessitating the abandonment of the trip.

At the Grand Canyon more than one-third of the party, including some ladies, showed their mettle by taking the trip down the Bright Angel trail, a very fatiguing descent of a mile to the river. Wednesday morning a mirage in the Mojave Desert caused much excitement, while the crossing of the Los Angeles aqueduct and the Tehachapi Loop naturally received much attention from the engineers.

Praise has been loud for the efficiency and courtesy of the special railroad representatives accompanying the party, G. S. Harner of the New York Central, and T. W. Conway of the Santa Fé.

Representatives of local committees of the various national societies boarding the train at Fresno and other points near San Francisco were enthusiastic over prospects for successful meetings.

Port Authorities Meet

The American Association of Port Authorities held its fourth annual meeting at Los Angeles, Sept. 13-15. J. P. Gilmer, Los Angeles Board of Harbor Commissioners, acted as chairman of the convention. The following papers were presented and discussed: "Recent Port and Railway Development in Philadelphia," by John Meigs, director Department of Wharves and Docks; "Port Terminal Development," by Paul P. Whitham, Seattle; "Public Control of Our Waterfront and the Obstacles to Be Overcome," by E. F. McSweeney, Boston; "Free Ports," by Calvin Tompkins, New York City; "Assessing Scientific Port Charges and Basis of Method of Such Charges," by Ernest M. Loeb, president Board of Harbor Commissioners, New Orleans; "The Best Method for Developing Port Traffic," by J. P. Gilmer, Board of Harbor Commissioners, Los Angeles.

The report of the resolutions committee, approved by the association, called for the appointment of committees to investigate ten subjects involving problems of interest to port authorities. These committees will report results of their studies at the next meeting.

J. J. Dwyer, chairman, Board of San Francisco Harbor Commissioners, was elected president of the American Association of Port Authorities for the ensuing year, and Montreal was selected as the meeting place for the 1916 convention.

President Marx Discusses Ideals and Art in Engineering

Charles D. Marx, president of the American Society of Civil Engineers, opened the forty-seventh annual convention of the society at San Francisco, Sept. 16, with an address in which he discussed in detail idealism and art in relation to engineering. His thesis was that the engineer is a practical idealist, that in the construction of sanitary work, irrigation projects, railroads, bridges and other engineering structures he makes it possible to bring to the masses such comforts and advantages without which the attainment of a high moral and intellectual civilization is impossible. By citations from men such as Emerson and Kipling he threw into relief the idealistic side of engineering work.

In discussing art in relation to engineering he emphasized the intrinsic, artistic character of a structure well fitted to perform the function for which it was designed, even though devoid of ornament as that term is usually employed.

Extracts from his address will be found on page 378 in this issue.

Business Matters

The business part of the program was unusually brief. Many suggestions were received as to the time and place of the next convention. Among the places Pittsburgh led with 118 votes, Boston was second with 51 and Chicago third with 48. September, by a very large majority, was recommended as the time for the convention. The entire matter, however, was referred to the board of direction for action.

The meeting also referred to the board of direction a resolution of the Seattle Association of Members of the society, suggesting that the parent body urge the establishment of a greater number of weather bureau stations in order that more complete observations may be made of precipitation, evaporation and snow storage.

Social Events

Thursday evening was devoted to a reception, dinner and dance at the Old Faithful Inn in the Exposition Grounds and at three o'clock Friday afternoon a special train conveyed the members and their guests to Del Monte on the shore of Monterey Bay, from which point several trips were made to points of scenic interest.

Goethals Day at the Exposition

Major-General George W. Goethals was honored at the Panama-Pacific International Exposition on practically the same scale as were former Presidents Taft and Roosevelt. Sept. 7 was designated as Goethals Day and appropriate ceremonies were arranged, the most popular of which was the address by the "canal builder" himself, delivered in the Court of the Universe to as many as could stand within reach of his voice.

In his speech Major General Goethals epitomized his views on the future management of the canal zone by saying: "I am going to advocate to Congress that the United States open up the canal zone to American merchants and manufacturers, but restrict to American citizens the use of the canal zone for business purposes." He reviewed the history of the canal project, beginning with activities prior to the nineteenth century, touched on the policies at Washington during various administrations and recounted some of the difficulties in governing the people of Panama. He made the point that it was not lack of sanitation, but lack of money that forced the abandonment of the French project.

The United States has not enough dock room at the canal terminals, he pointed out, even though commerce through the canal is at low ebb now on account of the war. Additional docks, however, are to be built. In commenting on the fortifications, he said: "The military force on the zone is sufficient to take care of any raid which might be made by a foreign power and beyond that we have not gone."

After planting a tree from the Isthmus in the permanent Exposition gardens, Major General Goethals was presented with a casket of jewels from the tower of jewels by C. C. Moore, president of the exposition.

French Engineer Leaves Trenches to Attend Engineering Congress

Jean de Pulligny, who gained a wide acquaintance in the United States while head of the French mission of engineers studying American engineering practice, was granted a two-months' leave of absence from the French army in order to represent his government at the International Engineering Congress, in San Francisco, this week. M. de Pulligny has been a familiar figure at American highway conventions for several years, being called on often to compare American with French road building and maintenance practice.

At the beginning of the war M. de Pulligny rejoined his battalion, in which he had held the rank of major previous to his resignation several years ago, and was promptly assigned, with his former rank, to take charge of a road-building detail at the front. His command consisted of 700 men, with 235 horses and 20 motor trucks. Of the trucks some (steam-propelled) had a carrying capacity of 10 tons. On account of the heavy traffic in munitions and food supplies—carried largely by heavy motor trucks and trailers—the building and maintenance of the roads to the front and along the trenches is most important, and M. de Pulligny's command was occupied entirely with this work.

He left the front Aug. 26 and came directly to the United States, stopping for a day only in Paris, which he had not seen for a year. When asked to discuss the war, M. de Pulligny stated that his mission was one of international courtesy and that he desired to refrain from talking on a matter that was the subject of much controversy in the United States.

F. H. Newell Appointed Member of Illinois Board of Examiners

F. H. Newell, head of the civil engineering department of the University of Illinois and, previous to that, consulting engineer of the U. S. Reclamation Service, has been appointed a member of the Illinois Board of Examiners of Structural Engineers. Mr. Newell was in the Government service for over twenty-six years, having entered it in 1888. His appointment as head of the department of civil engineering at the University of Illinois was noted on page 599 of the May 8 issue of this journal.

Thinks San Francisco Will Soon Need Rapid-Transit System

Discussion on transit problems at the first municipal session of the International Engineering Congress developed comment from M. M. O'Shaughnessy, city engineer of San Francisco, that in a very short time a system of elevated tracks would be necessary in that city. Preliminary studies that have already been made show that the double-track elevated line may be expected to cost $800,000 per mile, as against $3,500,000 per mile for a subway system. He estimated the construction of surface lines to cost about $215,000 per double-track mile. He pointed out that under present traffic conditions a trip to the western residence district during rush hours requires 20 min. longer than would be required with an effective rapid-transit system, and that this time saving multiplied by the total number of passengers carried represented an annual saving warranting a considerable investment in a rapid-transit system.

Irrigation Congress Convenes for Thirty-second Time

The Twenty-second International Irrigation Congress held its opening session in Stockton Sept. 13, and followed this with successive sessions in Sacramento, Stockton and San Francisco, visiting some of the more important irrigation systems of the San Joaquin Valley during the latter part of the week and holding the concluding session at the Exposition Sept. 20. The resolutions adopted included recommendations that Government funds be used for the completion of unfinished reclamation projects outside of those begun by the U. S. Reclamation Service, and that the financial system of the service be revised so that administrative costs shall not be charged against the settler. The principles of the Newlands-Broussard river regulation bill, which urges Federal legislation for adjudication of water rights on interstate streams on the basis of private appropriation and beneficial use, were commended.

The following officers were elected unanimously: Richard F. Burgess, El Paso, president; J. S. Dennis, Calgary, first vice-president; George Albert Smith, Salt Lake City, second vice-president; L. A. Nares, Fresno, third vice-president; Burt Grunwald, Denver, fourth vice-president; L. Clapp of Hatch, N. M., fifth vice-president; Arthur Hookes, Spokane, secretary.

Consumer Protected by Ruling on Fire Hydrant Water in Indiana

The State Board of Accounts of Indiana has ruled that cities owning waterworks systems in that State must estimate the cost of all water used from fire hydrants and charge themselves a proper rental for it. The ruling follows the Indiana utility commission law, which provides against discrimination by any utility corporation against any customer.

Water Leakage Survey Recommended for Minneapolis

Stating that Minneapolis loses 200,000,000 gal. of water per year, the value of which is $30,000, F. W. Cappelen, city engineer of that city, has recommended that an engineer be engaged to carry on a leakage survey of the water distributing system, so that leaks in the mains may be found and repaired.

Baltimore & Ohio to Build Large Coal Pier at Baltimore

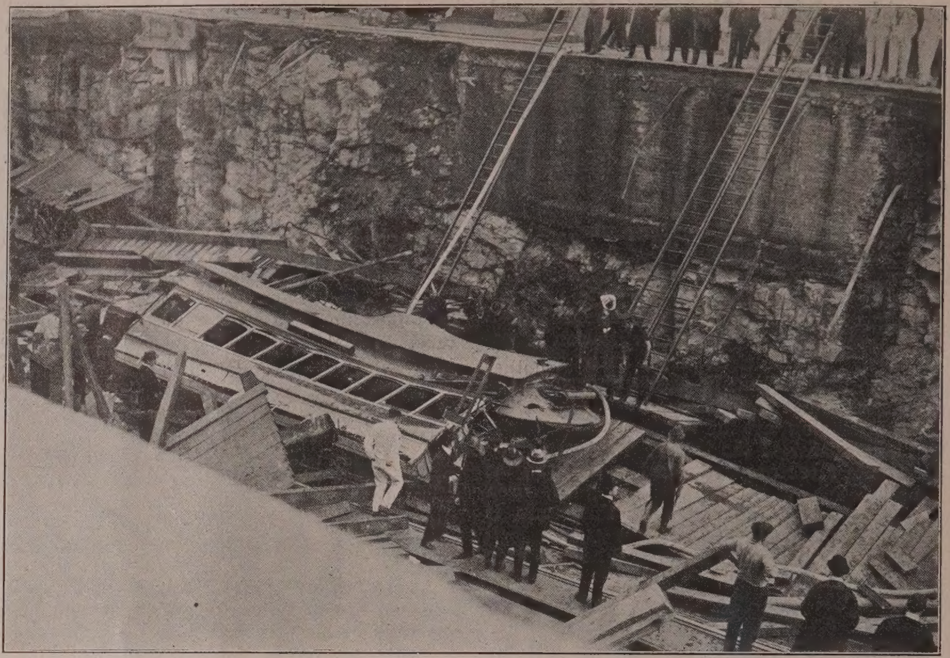
A coal pier to cost $1,500,000 and have a yearly capacity of 10,000,000 tons is to be built by the Baltimore & Ohio Railroad at the company's Curtis Bay terminal at Baltimore, authority having been voted recently by the board of directors. The pier will be 700 ft. long by 115 ft. wide, of steel construction throughout. There will be two car dumpers inshore, built in units and equipped with rapid-moving belts leading to movable towers on the pier, which can load into vessels on either side; or the entire loading capacity can be directed to one vessel. The car dumpers will be capable of handling cars 53 ft. long and unloading forty 100-ton cars per hour. The belts for conveying the coal will be run at speeds of from 250 to 500 ft. per minute, thus giving a capacity of from 3000 to 6000 tons per hour.

The necessity for the pier has arisen from the large increase in coal traffic from Curtis Bay, the tonnage this year to July 31 having exceeded that for all of 1914. Work on the improvement will therefore be started as soon as the contracts can be let, and it is estimated that eighteen months will be required for its completion.

The pier was designed by Francis Lee Stuart, chief engineer of the railroad.

Collapse of Street Decking Follows Subway Blast

(*Continued from page 397, first column*)



STREET CAR PLUNGED INTO SUBWAY CUT WHEN DECKING SUPPORTS GAVE WAY

ported by the original brick vault walls, which extend practically to the bottom of the 28-ft. cut. The remainder of the street space between the working face and the last permanent steel set was a great open pit, littered with steel beams and the wreckage of the wood deck, across the top of which lay the two street-car tracks, and in which were the wrecks of a street car, a large motor truck and several delivery wagons. The latter, according to witnesses, had been standing along the curb over the collapsed section at the time of the accident. The street car, which had been northbound, lay north of the middle of the block below Twenty-fifth Street. Its trucks were still upright on the rails, the brakes were set tight and the power shut off, and there were no marks of any kind on the strip of asphalt, still intact between the rails, to indicate that the car had jumped the track at any time previous to its fall.

Stories of Eye-Witnesses

The blast was fired by a regular firing crew, which goes to work before the regular day shift comes on at 8 a. m. The day shift had not entered the cut, which accounts for the small total of seven deaths; four of the men killed were subway laborers. The man who fired the shot is reported to have said that he saw nothing, as he was bending over the battery, and when he looked up at the time of the collapse, the cloud of dust cut off his view. Four flagmen and four additional men, it is stated, were at their stations at each end of the collapsed section and on Twenty-fourth Street to keep traffic off this part of the decking until after the shot had been fired. The two flagmen at the north end and the guards on the cross street apparently fulfilled their tasks. One of the two flagmen at the south end is reported to have told the engineers of the Public Service Commission that the motorman of the car which was wrecked failed to heed his signal to stop, and that he boarded the front step of the car, which was going at fair speed, in an effort to halt it. This man was carried to the bottom of the cut with the car, but escaped without serious injury. The heavy motor truck which fell in was at the extreme south end of the section, at least 250 ft. from the blast, and appears to have been partly on decking which was supported by the permanent steelwork.

Probable Cause of Collapse

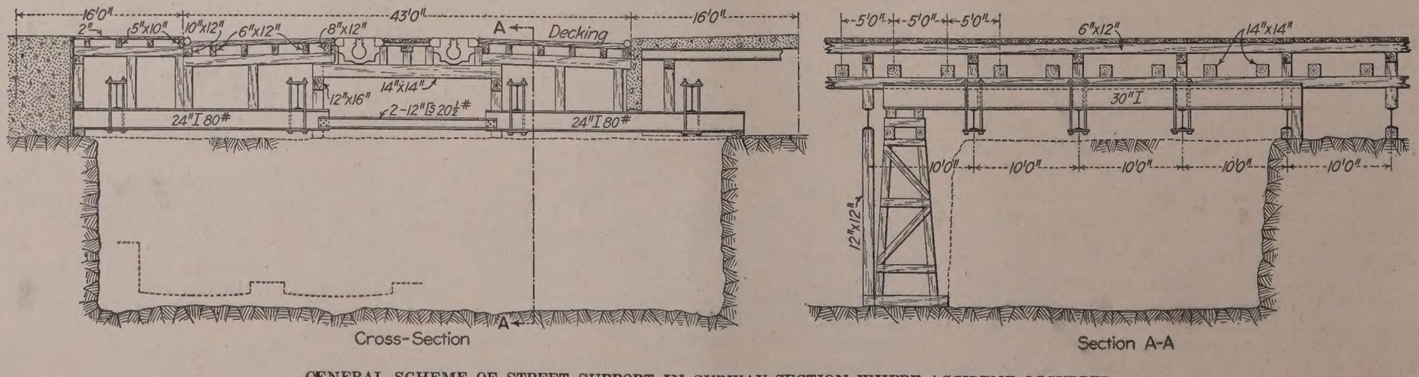
It is possible, though no definite evidence had been brought out at the time of going to press to support the view, that the collapse was due to the knocking out of one or more of the posts or towers under the south end of the east pair of needle-beams by rock hurled from the blast. This cause alone, it is thought, would not result in serious collapse of the decking. In this connection, it must be remembered that the car was on the east track, which was largely supported by the east needle-beams. The fact that the power was off the car and the brakes set does not prove the theory advanced by some that the car had been brought to a halt, that the decking collapsed from north to south progressively, and that the car rolled down the tilting track into the hole. In this event, the car would probably have left the rails and scored the asphalt between them. It would be most natural for the motorman to shut off the power and apply the brakes as soon as the collapse began, and it seems highly probable that this is what actually occurred. It seems plausible, then, to consider that some of the posts under the rear ends of the east needle-beams, and perhaps also under the bay of cross-beams behind them, were first knocked out. The weight of the trolley tracks, yokes and concrete-encased cable ducts, probably helped by the vibration and impact of the oncoming car, may then have thrown down the bents of posts, both below and above the cross-beams, progressively from north to south. The collapse, although progressive, must have occupied a very brief space of time, as the car did not have time to turn over or leave the rails between the instant the collapse began and the time the car reached the bottom of the cut. In the photograph the car appears to have turned over because the superstructure collapsed sideways and fell across the car floor, which remained nearly horizontal.

Officials Hurry to Disaster

Valves on the numerous gas and water lines broken by the collapse were closed, by forces of the contractor with extraordinary dispatch. There was no large sewer in the affected section, and only a little water accumulated in the cut. This was pumped out by fire engines which arrived on the scene in response to an alarm turned in by someone under the impression that a gas explosion had occurred. Firemen and police promptly took charge of the work of removing the dead and injured from the wreckage. Within a short while Mayor Mitchel, Chairman McCall and Commissioner Hayward of the Public Service Commission, Robert Ridgway, chief engineer of subway construction, D. T. Turner, deputy engineer of subway constructing, John F. Meyers, engineer of the division which includes this section and the chief engineer for the contractor, the U. S. Realty & Improvement Company, were on the scene. Mr. Ridgway remained all day, directing the work of restoring service on the broken public utility lines and of clearing the wreckage.

Wrecking Operations Begun Promptly

George H. Clark sent the traveling locomotive crane used on the Times Square subway section by the Holbrook, Cabot & Rollins Corporation, down Seventh Avenue to the north end of the break. The contractors for the section on which the collapse occurred set up a jinny-wink on the west side of the break at Twenty-fourth Street. Within a short time both were busily engaged in removing the wreckage. At the same time, the contractor for the section secured two of the cableways commonly used in sewer construction, and by night had them set up and partly rigged, spanning the break on opposite sides of the street from north to south. It will probably be a week or more before traffic can be restored across the gap and construction resumed.



Cross-Section

Section A-A

GENERAL SCHEME OF STREET SUPPORT IN SUBWAY SECTION WHERE ACCIDENT OCCURRED

Men Who Made International Congress a Success

Some Facts Regarding the Officials Whose Labors Have Resulted in the Meeting Held This Week in San Francisco

The International Engineering Congress, toward which the engineering fraternity has looked forward so long, has cost more in the way of personal effort than is generally realized. All the credit for the work, which was begun almost four years ago, cannot be given to any one man or to any group of individuals, for able assistance has come from many quarters and in one way or another a great number of engineers have contributed toward the success of the meeting. However, the responsibility for shaping the policy through two and a half years of the later preparation and the great burden of handling the rush of work in making final plans for the Congress has fallen directly upon one group of men who have worked long and energetically without any financial remuneration—the committee of management.

Chairman Durand

Prof. W. F. Durand, who, from the inception of the plan, served as director of Congress affairs in the position of chairman of the committee of management, graduated from the U. S. Naval Academy in 1880 and served seven years in the Navy Engineer Corps. In 1883 he was assigned to special duty as assistant professor of mechanical engineering at Lafayette College where he remained until 1885. He was at Worcester Polytechnic Institute in 1887, and professor of mechanics and superintendent of the mechanical department at Michigan State Agricultural and Mechanical College from 1887 to 1891. In 1888 he received the degree of Ph.D. from Lafayette. He went to Cornell University in 1891 as professor of marine engineering and principal graduate school of naval architecture and marine engineering. Since 1904 he has been at Stanford University, California, where he holds the position of professor of mechanical engineering.

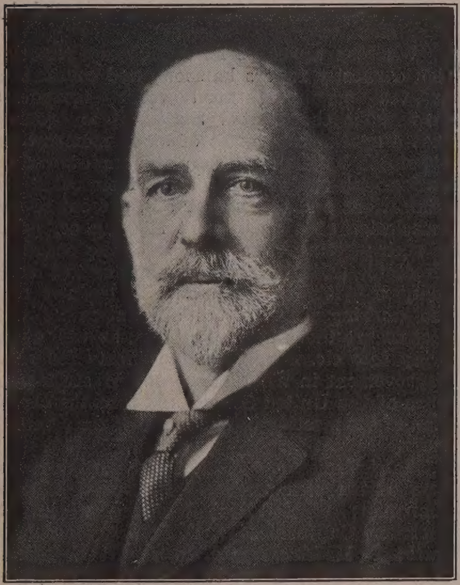
Secretary-Treasurer Cattell

The office of secretary-treasurer of the committee of management has involved a work of importance second only to that of the office of chairman. The usual problems of a technical secretary were multiplied more than five-fold in the secretarial work that covered the combined interests of five national engineering associations. In this capacity W. A. Cattell, consulting civil engineer, has earned distinction in giving painstaking supervision to the detail work. Mr. Cattell graduated from Lafayette College in 1884. In recent years his work has included many phases of engineering, ranging from a report on a proposed 164-mile Alaskan railroad to the valuation of public utility properties in Southern California.

Other Officers

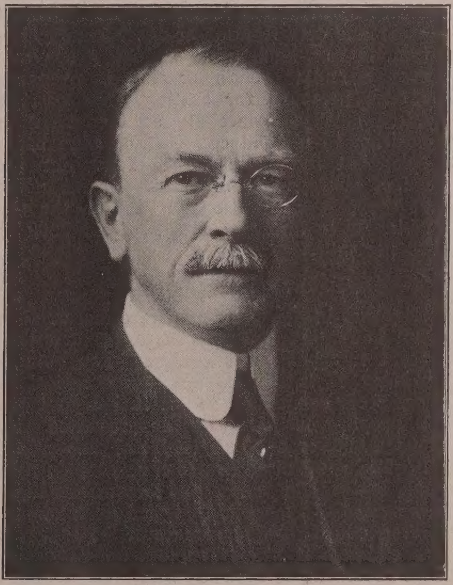
Major-General George W. Goethals needs no introduction to readers of the Engineering Record. Those who know him personally will readily imagine how reluctantly he came into the limelight as honorary president of the congress. Once enlisted in the work, however, he took an active interest in it, supervised the preparation of most of the text in the volume on the Panama Canal and himself wrote one

Prime Movers in Organizing and Directing World Congress of Engineers



PROF. WILLIAM F. DURAND, CHAIRMAN, COMMITTEE OF MANAGEMENT

MAJOR-GENERAL GEORGE W. GOETHALS, HONORARY PRESIDENT OF CONGRESS



W. A. CATTELL, SECRETARY-TREASURER, COMMITTEE OF MANAGEMENT

MUNICIPAL AUDITORIUM IN SAN FRANCISCO WHERE MEETINGS OF CONGRESS WERE HELD of the more important papers. Major-General Goethals went to San Francisco two weeks prior to the opening of the Congress in order to take part in Goethals' Day ceremonies at the Exposition. Exposition officials secured his consent to this only after a year and a half of persuasive effort.

A. M. Hunt, as chairman of the committee on papers, has rendered most valuable service in the arrangement and classification of topics and the selection of authors. E. J. Dupuy, although not an engineer, has done creditable work as executive secretary, giving particular attention to the handling of foreign correspondence and translations. Edwin Duryea, Jr., has devoted much time to working out a satisfactory plan of presentation. Thomas Morrin has had charge of local affairs and George M. Brill, called upon in the rush preceding the convention to take charge of Congress headquarters, greatly expedited the successful carrying out of eleventh-hour plans.

New Committee Will Harmonize Good Roads Movement

(*Continued from page* 397, *second column*)

Location was agreed upon as the most important phase of highway construction, because of its being the only feature not subject to wear and deterioration or obsolescence. Location, it was held, must include grade and curvature and the engineer must be prepared to resist pressure for cutting down cost of location surveys, especially as the strongest opposition to a road construction plan often develops at the outset, when funds for the work of surveys are required. It was noted that the cost of location surveys on the Columbia River highway ranged from $200 to $400 per mile.

Highway Bridge Problems

Highway bridge problems were discussed in detail and there was general agreement that present methods must change. The opinion was that it is unwise and uneconomical to allow steel companies to select bridge types and prepare designs. It was estimated that $100,000,000, or one-half the total amount expended in the United States each year on road work, is used for repair and renewal of highway bridges. This was regarded as unreasonable; one-half of this sum could be saved, it was claimed, if proper supervision of design were provided. A highway bridge department, dependent on the Legislature for support, was suggested as a suitable protection. Citations indicated that there is a tendency to keep down the first cost of highway bridges to an uneconomical limit.

In the past twelve years Kansas highway bridges have suffered damage, chiefly due to floods, totaling $3,000,000, according to W. S. Gearhart, Kansas State engineer, who described Kansas bridges built low enough to allow flood waters and the drift they carry to flow over the submerged structures without damage.

Highway Finances

The question as to whether highway funds could best be raised by bond issue or by taxes was the subject of discussion for an entire session. The State of Washington is building roads successfully without bond issues, the State tax for this purpose totaling 2.5 mills on the dollar. Road building without bond issues was to be advocated where feasible, it was agreed, especially for temporary roads, but it was shown that under the bond issue plan there was greater probability that those who use the roads will be those who pay for them. Public service corporations are required to have approval of public utility commissions before they can issue new securities and some similar protection for the public was urged when bond issues for highways are proposed. The law should, at least, require and provide for adequate surveys and engineering supervision before authorizing the bonds finally. The point was made that no financial policy is successful which does not provide protected roads of low cost for light traffic in remote districts as readily as costly pavements for main thoroughfares between cities.

An inquiry about experience with reinforced-concrete pavements brought several citations tending to show that thin pavements with light reinforcing would be found strong and durable. One such pavement was built in two courses with reinforcing imbedded between. The cost for steel was 1 cent per square foot, the reinforcing being placed in 4-in. mesh that weighed 40 lb. per 100 sq. ft.

Medals for Associations

On the evening of Sept. 14 a banquet was held in honor of distinguished guests of the Congress. Attendance was even larger than had been expected, and the spirit of the gathering was pronounced unusually good. On the morning of Sept. 15 the session was held in Oakland, as usual, but the afternoon session convened in Festival Hall on the Exposition grounds. A commemorative medal was presented by Exposition officials to each of the four associations included in the Pan-American Road Congress. After a brief business session the meeting was adjourned until the morning of Sept 16 to allow the remainder of the afternoon for a personally conducted visit to certain exhibits of interest to road builders.

Military Highway Proposed

A warm debate that continued for 2 hr. past closing time Sept. 16 brought out various views of the advisability of calling the attention of Congress to the need for a highway on the Pacific Coast to be used for military and commercial purposes. Samuel Hill, president of the Pacific Highway Association, explained that such a road is a vital need at this time, for it would simply be an insurance of American safety. Opposition came from a few delegates from the central States who wanted no preference shown by Congress to any particular section in assisting highway projects. Charles F. Stern, California highway commissioner, pointed out that this was a national, not a local, question; like other questions of preparedness, the only time to attend to it was before a crisis came. The following resolution was then passed by an almost unanimous vote:

"Resolved, that the Pan-American Road Congress recommends to the Congress of the United States the advisability of investigating the necessity of building a hard-surfaced highway along the Pacific Ocean side from Mexico to British Columbia and other national highways to be used as military and commercial highways."

"Safety First" on Roads

The afternoon session of Sept. 16 was marked by an interesting discussion of "safety first" as applied to the highway. The matter was brought up by C. A. Kenyon of Indiana, who expressed regret that a place had not been assigned on the program to this topic. He proposed that there be established in each State highway department a safety-first bureau, to be in charge of an engineer vested with police powers and delegated to draw up such regulations and standards of a reasonable character as would contribute to safety on the highway. Mr. Kenyon suggested, among other matters, that the safety-first engineer concern himself with the following subjects: 1. The gathering of statistics regarding accidents, on which regulations and standards would be predicated. 2. The erection of fences on bad side-hills and at dangerous turns. 3. The placing of suitable signs at highway and railroad crossings and at sharp curves. 4. Examination of applicants for drivers' licenses, to determine their competence. 5. Clearing out of brush that obstructs the view at intersections. 6. Determination of penalties, for statutory enactment if necessary for violation of traffic regulations.

These views were heartily seconded by those entering into the discussion, the sentiment being especially strong for the revocation of the licenses of those convicted of the violation of traffic rules.

Massachusetts Practice

The closing session, Sept. 17, was presided over by Col. W. D. Sohier, chairman of the Massachusetts Highway Commission. In answering the many questions about Massachusetts experience, Colonel Sohier pointed out that it usually costs about 25 cents per ton-mile to deliver road materials, although under the plan used in France, involving a traction engine and two trailers, the cost is 5 to 7 cents. If the annual maintenance and upkeep of a pavement exceeds 12½ cents per square yard, it is economical, he thought, to pay the interest and sinking fund on an investment in a more expensive pavement. Colonel Sohier explained his reference to contraction joints by saying that when a concrete pavement takes its final set it always contracts twice as much as it ever expands again. Nearly all the Massachusetts highways are thrown at least 2 in. by frost and the resulting cracks are filled with tar and sand.

Harmony in Good Roads Movement

The following resolution was adopted by unanimous vote:

"Whereas the American Highway Association earnestly favors harmony and correlation of the organized good roads movement throughout the United States, it is ordered that a special committee of seven members be appointed by the chairman and empowered to confer with similar committees from other organizations and to consider and present to the association at a subsequent meeting or, prior to such meeting, at a meeting of the board of directors, suitable recommendations for such changes in the constitution and by-laws and the working plan of the association as will best secure those desired results, as well as to bring into closer relation the efforts for road improvement in the Eastern and Western portions of the United States, and that the chairman of the meeting be chairman of the committee."

The chairman appointed the following members of the committee: S. E. Bradt, Illinois, chairman; W. R. Roy, Washington; A. B. Fletcher, California; W. D. Sohier, Massachusetts; T. H. MacDonald, Iowa; W. E. Atkinson, Louisiana; G. P. Coleman, Virginia, and F. F. Rogers, Michigan.

The American Highway Association elected the following officers for the ensuing year: Fairfax Harrison, Washington, president; L. W. Page, Washington, vice-president; John Burke, Washington, treasurer; James R. MacDonald, Connecticut, E. J. Mehren, New York; George L. Cooley, Minnesota, Joseph Hyde Pratt, North Carolina, Henry G. Shirley, Maryland, W. T. Beatty, Illinois, and C. R. Kenyon, Indiana, directors.

Batavia Sewage Pumping Station Wrecked by Explosion

The superstructure of the Batavia, N. Y., sewage pumping station was completely wrecked and the sewage pumps put out of commission by an explosion that occurred between the main floor and second floor of the plant Sept. 18. The accident is attributed to a workman's lighting a match to relight a gas jet that was usually kept burning in a vent pipe leading from beneath the second floor to the outside atmosphere. Mayor Burkhart telegraphed Chester & Fleming, consulting engineers, of Pittsburgh, of the happening and Messrs. Chester and Schlumpf of that firm took charge of the situation Sept. 19. Temporary pumps will be installed to handle the sewage until permanent improvements can be effected. The information on which this report is based was received by telegraph from Chester & Fleming.